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HANDBOOK

FOR THE

10-IN. R.M.L. GUN AND MOUNTINGS.



1899.

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LONDON:

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Price One Shilling.

10-INCH R.M.L. GUNS.

| Description. | | | | | Marks I and II. | Marks III and IV. 9-inch, Marks I, II, and III. |
|-------------------|---------------------------------------|---------|----|----|--|---|
| Material | { exterior | .. | .. | .. | Wrought-iron. | Wrought-iron. |
| | { tube.. | .. | .. | .. | Steel. | Steel. |
| Length | { nominal | .. | .. | .. | 170.75-in. | 147-in. |
| | { total | .. | .. | .. | 189-in. | 145.75-in. |
| Preponderance | .. | .. | .. | .. | 3 cwt. | Nil. |
| Bore | .. { calibre | .. | .. | .. | 10-in. | 10-in. |
| | { length | .. | .. | .. | 145.5-in. | 125-in. |
| | { system | .. | .. | .. | Woolwich. | Polygroove. |
| Rifling.. | { twist | .. | .. | .. | 1 in 100 at breech to 1 in 40 at muzzle. | 1 in 100 at breech to 1 in 35* at muzzle. |
| | { length | .. | .. | .. | 118-in. | 101.3-in. |
| | { grooves { number | .. | .. | .. | 7 | 32 |
| | | { depth | .. | .. | .2-in. | .05-in. |
| | | { width | .. | .. | 1.5-in. | .7-in. |
| Vent | .. { material | .. | .. | .. | Copper. | Steel. |
| | { description.. | .. | .. | .. | Radial. | Radial. |
| | { distance from end of bore | .. | .. | .. | 11-in. | 2.5-in. |
| Chamber.. | .. | .. | .. | .. | Conical. | Conical. |
| Weight | .. | .. | .. | .. | 18 tons | 12 tons |
| Ballistic effects | { muzzle velocity in f. s. | .. | .. | .. | 1379 | — |
| | { „ energy in f. t. | .. | .. | .. | 5406 | — |
| with full charge | { Penetration of w.-i. at 1,000 yds., | .. | .. | .. | — | — |
| | { inches | .. | .. | .. | 12 | — |

Mark II.

(Plate I.)

The gun is built up by shrinking wrought-iron coils upon a steel "A" tube, which is forged solid at one end. The coils are "hook-jointed" to ensure them retaining their position. The breech coil projects beyond the tube, and is cut with a thrust thread for the cascade screw, which has a corresponding thread; a portion of these threads is cut away on the right side to form a small gas escape channel, which extends the whole length of the cascade. The "B" tube extends to the muzzle, and is joined to the breech coil by an intermediate coil "1 B," and over the breech coil is shrunk the "C" coil or trunnion jacket.

A few Mark I guns were made: they differ in having "1 B" coil, breech piece, and jacket in one piece.

Mark III, converted from 9-in. Marks I, II, and III.

The Mark III is the 9-in. gun bored out to 10-ins. diameter, and externally altered to adapt it for service on the R.C.D. high angle mountings, Marks III and IV. The cascade is removed, and the trunnions cut down and fitted with guides to allow the gun an axial recoil in the cradle of the mounting. The guides are fitted with brackets, by which the gun is secured to the buffers in the cradle.

* In Mark IV gun the rifling is of Mark II pattern, "twist increasing from 1 turn in 100 calibres at breech end of rifling to 1 turn in 30 calibres at muzzle." This is the only difference between Marks III and IV guns.

The gun is fitted with a steel cone vent and a removable head for use with electric vent sealing tubes; the head of the vent is furnished with a hinged cover which retains the tube when the gun is fired, and thus prevents the rush of gas and consequent erosion of the vent. The hinged cover is retained in position over the vent by a keep pin and chain. It strikes the bore 2.5 ins. from the end, and is at an angle of $6^{\circ} 3'$ with the axis, so as to be at right angles with the conical chamber.

A steel wrench is provided for removing the head of the vent when necessary.

The vent is preserved by a bronze cover, which is in two parts, the lower part being fitted round the vent head with a water-tight joint and the upper part secured to it by a bayonet joint on either side.

SIGHTS.

These guns, when mounted behind shields or in casemates, have two tangent, one centre hind, and three fore sights; in all other cases they have two tangent and two fore sights. Tangent sights "A" are for sea fronts, "B" for land fronts. They are set at an angle of $1^{\circ} 10'$, correction for drift.

For Guns mounted on Land Fronts.

Fore-sights, *sides*.—These are of the drop pattern, and are stamped with the letter "H." Each consists of a pillar with removable steel acorn, a collar, and socket of gun-metal. The socket is permanently fixed in the gun; the pillar and collar each lock into it with a bayonet joint, so that when once the sight is in its true position it cannot be removed without first raising the collar and turning the pillar round a quarter of a circle.

Tangent.—These are of steel with bronze crossheads, having deflection leaves with notch .06 in. deep, and graduated to $0^{\circ} 40'$ right and left.

The bars are rectangular in section, having a removable range strip on the rear face graduated to 5,000 yards, with M.V. 1,379 f.s. They are interchangeable with the right and left side of the gun.

For Guns mounted on Sea Fronts.

Fore-sights, *sides*.—These are of drop pattern and have a sighting blade to facilitate laying. They are left and right, and are so stamped, the vertical edge of the sighting blade being turned inwards in each case when the sights are in position in the gun.

Fore-sights, *centre*.—These are of drop pattern, and are stamped with the letter G. They have a removable steel acorn apex screwed into the pillar.

Hind-sights, *centre*.—These are of bronze and furnished with cross-heads having deflection leaves with sighting blades. The cross-heads are graduated to $1\frac{1}{2}^{\circ}$ right and left, and the deflection leaves are clamped on the front face. The bars are hexagonal in section, and graduated to 8° , reading to 5', on front face, and to 4,000 yards on rear face, for M.V. 1,379 f.s.

Tangent.—These are left and right, and are so stamped. The vertical edge of the sighting blade of the left sight is turned inwards, when the sight is in position in the gun, to correspond with the sighting blade of the left fore-sight.

The vertical sight-blade, in height, corresponds to a mean length of about 1,000 yards on the yard scale, and is for use in conjunction

with the hydroclinometer, index plates and readers, or any similar means of giving elevation, line only being obtained by the sights. When using the sight-blade the sight should be clamped about 1,000 yards less than the estimated range if the ship is approaching, and at the estimated range if the ship is retiring. By this means the gun can be laid for line at any time during the period the ship takes to move 1,000 yards.

The deflection leaf has a sight notch 0.06 in. deep, and is for use when the elevation and line are both to be obtained by means of the sights.

The bars are rectangular in section, each has a removable range strip graduated to 5,000 yards, with M.V. 1,379 f.s. The crossheads are graduated 2° right and left.

Mark III Gun on High Angle Mounting.

Sights are not used.

Elevation is given by clinometer applied on the planes for that purpose, or by "gear, elevation, indicators," see page 17.

Direction or training right and left is obtained in connection with position-finder and traversing arc.

MUZZLE DERRICKS, MARK I AND II GUNS.

Muzzle derricks are provided for raising the projectile to the muzzle, except in the case of guns mounted in casemates, behind shields, on high angle mountings, or where the emplacements are provided with sunken ways and slide derricks. They are of bronze, and consist of a band fixed round the chase near the muzzle, and a derrick secured to the band by two bolts. The derrick projects over the muzzle, and is supported in that position by a bridge piece which rests on the gun. The tackle is hooked into the eye at the top with the back of the hook towards the gun, and the point through the loop to prevent the tackle from slipping. The derrick should be turned back on the chase after loading, and always kept there when not actually in use.

PLATES, ELEVATING, MARK I AND II GUNS.

These are for the right and left side of the gun, and secured to it by fixing screws. Each consists of a metal plate, steel pivot, keep-pin, and fixing screws. The pivots are screwed into the plates, and held in position by the keep-pins; they connect the gun to the elevating arcs of the carriage. There are different marks to suit the various guns and carriages.

PLATES, INDEX, MARK I AND II GUNS.

A metal index plate, graduated from 10° elevation to 6° depression, is secured by fixing screws to each side of the gun, and a metal "reader for index plate" to each side of the carriage, to show the angle at which the gun is laid. A plate, engraved with a yard scale calculated for full charge and height of battery above mean-tide level, is fitted on the rear face of the index plates, the engraved lines being filled in with red and black wax, alternately, to facilitate reading.

There is a separate mark for each pattern carriage.

BRACKET HYDROCLINOMETER.

This is of bronze and secured to the cascables of Mark II guns when mounted on small-port carriages.

CARE AND PRESERVATION OF GUN AND FITTINGS.

(Extracts from "*Regulations for Magazines and Preservation of Artillery
Matériel*").

General Instructions.

"473. A 'Memorandum of Examination' is issued with each rifled gun It contains a drawing showing the principal dimensions, with a short description of the construction and rifling as well as the particulars of any slight original defects or tool marks which may have existed at the date of issue. In it are recorded in detail the number of rounds fired, and the date and result of any examination.

"474. This memorandum will remain in charge of the officer who has possession of the ordnance, and a certificate to the effect that it is in his possession and complete up to date, will be included in the Annual Return of Rifled Ordnance, Army Form G 872

"475. At the conclusion of each day's firing an entry will be made in the memorandum by the officer in charge, giving a detail of the rounds fired (including blank charges), so that an accurate record of the firing may always be kept up.

"477. A statement of the results of the examination of any piece will be added to the memorandum by the inspecting officer, or other examiner who performs the duty, and when the gun is returned into, or issued from, store, the memorandum will accompany the transfer vouchers.

"478. If at any time the memorandum be lost or damaged, a duplicate can be obtained from the Chief Inspector, Woolwich, by whom also inside sheets for continuation of the record of the number of rounds fired will be supplied on demand.

"479. All ordnance will, as far as possible, be examined after firing (either with powder or cordite) the numbers of rounds detailed below, and practice from such ordnance should cease until such examination shall have been carried out. In cases, however, where the examination would happen within a series of rounds allowed for practice, and thus cause inconvenience, the guns will be examined before practice commences, irrespective of the number being completed.

"480. In computing the number of rounds for examination purposes, four rounds of blank charges may be regarded as equal to one round with projectile, but in recording the rounds on the memorandum of examination "blank" rounds should be shown as such. Ordnance used for saluting purposes, or for time guns, should however be examined at least once a year or oftener if necessary.

"481. The following are the numbers of rounds after which each nature of ordnance must be examined:—

| | Nature. | No. of rounds with projectile. | Remarks. |
|--------|---------------------------|-----------------------------------|----------|
| R.M.L. | 12 in. 25 ton to 9 in. .. | 50 | — |

"481A. Should any accident occur, such as the bursting of a shell in the bore, the splitting of a vent, &c., immediate inquiry will be made into the circumstances, and the guns examined. If the Commanding Officer considers the damage to be of importance, he will send, without delay, a report of the circumstances through the same channel as his

Annual Return, forwarding, if necessary for the illustration of his report, gutta-percha impressions of the damage done to the guns.

"482. All ordnance, whether muzzle-loading will be kept in good preservation, the exterior being protected from the effects of the atmosphere by a sufficient coating of paint. The bore will be well cleaned and oiled, or lacquered, when not in constant use, with the following lacquer:—

| | | | | | | |
|-------------------|-----------|----|----|----|----|--------------|
| Lead | { black.. | .. | .. | .. | .. | 24 lb. 8 oz. |
| | { red .. | .. | .. | .. | .. | 6 „ 12 „ |
| Lamp black | .. | .. | .. | .. | .. | 12 „ |
| Oil, linseed, raw | .. | .. | .. | .. | .. | 9 gallons. |

The lacquer will be applied by means of a brush attached to a holder, and can be removed in a few minutes by brushing the bore with hot potash solution.

"483. At the close of each day's firing the bore will be washed and placed under metal, and as soon as dry will be oiled with a greasy sponge (a sponge cloth or piece of old linen tied over the piasaba brush).

"484. Ordnance, whether mounted or on skidding, will be depressed at the muzzle to prevent rain or moisture lodging inside, and when mounted the muzzle will be stopped with a tampeon

"486. All ordnance forming the armament of fortresses will be cleaned and painted biennially; but should it be found that those mounted on sea faces of works are in a bad state from exposure to the sea spray or those in casemates from damp and dripping, they will be cleaned and painted every year, and oftener if considered necessary by the O.C.R.A. On this point, considered as a question of expense, a sound discretion will be exercised.

"487. The paint used will be Pulford's magnetic oxide, unless it is considered necessary that the colour should harmonise with the surroundings of the work, when ordinary paint of a suitable colour will be used.

"488. Before the working parties commence work, the ordnance will be dismounted and placed on skidding, in such a position as to admit of the exterior and interior of the piece being thoroughly well cleaned. In cases where, from the nature or position of the work, it may not be deemed advisable to dismount the pieces, they will be raised out of their trunnion holes to a sufficient height to admit of all parts of the gun being thoroughly scraped and cleaned, the sight sockets, when necessary, being plugged with tow and tallow.

"489. Ordnance will be scraped on the exterior (the scrapers or old swords supplied for the purpose being previously sharpened) until the old paint and all rust which may appear beneath it are entirely removed; the axis lines, sight notches, and all marks will be completely cleaned out and rendered distinct, and the ordnance will afterwards be wiped over with a piece of old canvas or cloth. The radial copper vents will be cleaned with the vent-scrapers.

"490. The exterior of the piece will be painted with two coats of paint; the second coat will not be applied until the first coat has thoroughly set, and as in the process of mounting the ordnance the paint gets much rubbed, the second coat should be given, when possible, after the piece has been mounted.

"492. In the case of ordnance having a gas escape channel, the latter will always be kept clear, the outer end being merely stopped with a plug of greased tow when the gun is not in use.

Preservation of Sights.

"494. When mounted in exposed positions, or in batteries accessible to the public, unguarded by sentries, all the sights will be removed from the ordnance and kept in store, the sight recesses in the guns being filled with a plug of greased tow to keep out the rain and dirt. These plugs can be readily removed when it is required to fit the sights to the ordnance. Particular attention will be paid to the prevention of rust or grit accumulating in the sight recesses.

"495. The set-screw for clamping the centre hind-sight not being removable from the socket, will be tested to see that it works freely.

"496. The sights will be kept clean, free from grit, and oiled; the tangent sight bars should on no account be polished; the sliding leaf, as well as the collars of the fore-sights, should have free play.

"497. The exposed portions of the sights are bronzed if made of gunmetal, and blued if of steel, in order to preserve them from corrosion, and on no account will these parts be cleaned or burnished in such a manner as to remove the bronzing or blueing."

RIFLE, AIMING, 1-INCH, MORRIS, R.M.L. (MARK I).

This apparatus is for use with the gun in imparting instruction in laying, and consists of the following parts:—

Rifle, aiming, 1-inch, Morris, R.M.L.:—

| | | | |
|-----------------------------|----|-------------|--|
| Barrel, 1-inch | .. | .. | Steel, with socket (for breech blocks) axis pin, and retaining screw; lanyard guide, with pulley and axis pin; hinge pin and stop pin, with chain and eye bolt; barrel contact with insulating block and two fixing screws with insulating washers, and barrel terminal. |
| Breech blocks | { | electric .. | Steel, with needle, insulating bush, spiral spring, contact with insulating bush, and cap with insulating bush. |
| | | percussion | Steel, with striker, main spring, trigger and spiral spring, stud and cap; cocking lever, with axis pin and retaining spring, with fixing screws. |
| Frame, expanding | .. | .. | Bronze, in three parts, with six fixing screws, cone and nut, front and rear washers, and two securing nuts. |
| Lanyard, with firing lever | .. | .. | White line, 3 yards long. |
| Tube, aiming, 0.23-inch, D. | .. | .. | Steel, with nut, washer, and chamber bush, and rifle, aiming, 1-inch, Morris, R.M.L. |

Implements used.

Rifle, aiming, 1-inch, Morris, R.M.L.:—

| | | | | | | |
|----------------------|----|--------|-------------|----|----|---|
| Brush, cleaning | .. | .. | without rod | .. | .. | 1 |
| Extractor, cartridge | .. | .. | steel | .. | .. | 1 |
| Rod, cleaning | .. | .. | wood | .. | .. | 1 |
| Wrenches, | { | barrel | .. | .. | .. | 1 |
| | { | cap | .. | .. | .. | 1 |
| | { | cone | .. | .. | .. | 1 |

Tube, aiming, 0.23-inch:—

| | | | | |
|-----------------|-------|-------------|-------|---|
| Brush, cleaning | | without rod | | 1 |
| Rod, cleaning | | steel | | 1 |

The 1-inch barrel is $35\frac{1}{2}$ inches long, chambered, and rifled on the Henry principle, having 11 grooves with a twist of 1 turn in 60 inches in Mark I barrel, and 1 turn in 35 inches in Mark II; the length of rifling is $31\frac{1}{2}$ inches. It is fitted with a breech piece, which is furnished with a hinged socket for the reception of the breech blocks (one for electric, and one for percussion firing). The barrel is prolonged at the rear of the breech piece for the attachment of the expanding frame. A recess is formed at the breech end for the reception of the "Extractor, cartridge."

The frame for securing the 1-inch barrel in the muzzle of the gun, is expanded by a cone, fitted to the tube in such a manner that in turning the nut on front of frame, when in the gun, the frame is forced against the sides of the bore, thus securing the tube, and at the same time centring it with the axis of the piece.

The breech blocks are of steel and are prepared at the rear end to fit the socket in the breech piece, and furnished at the front end with a screw thread having two flats made upon it; the breech piece is prepared in a similar manner and thus admits of the breech being closed by the fourth of a turn of the breech block when in position. The breech blocks are furnished with a handle, to facilitate opening and closing the breech.

The electric breech block is furnished with an insulated steel needle. The needle is provided with an insulated contact, which engages with a similar contact on the barrel when the breech is closed. The barrel contact is furnished with a terminal for making connection with a battery. Another terminal is fitted to the barrel for the reception of the return wire from the battery. To ensure contact being made between the electric needle and the detonator of the cartridge, the needle is provided with a spiral spring and retaining cap.

The percussion breech block is furnished with a steel striker, actuated by a main spring. Fitted to the rear end of the striker is a trigger, which automatically engages with a recess in the breech block and retains the striker in the cocked position. The striker is cocked when the breech block is locked in the barrel, by means of a cocking lever pivoted on the under side of the barrel. In firing the rifle, the trigger is released by means of a firing lever and lanyard fitted to the upper side of the breech piece.

In order to obtain a direct pull on the firing lever from the rear, a lanyard guide furnished with a stop pin and chain, is hinged to the right side of the barrel in such a manner as to be capable of being extended at right angles to the barrel when required for use, and folded against the barrel when not required.

Care must be taken, before inserting the percussion breech block in the breech piece, to place the striker in the cocked position. This will be done by forcing the point of the striker into the breech block by means of the "Wrench cap," until the trigger engages with the recess prepared in the block for its reception.

The 0.23-inch, aiming tube "D," is of special pattern and is furnished with a chamber bush and brass collars, which fit the 1-inch barrel. The tube is provided at the muzzle with a milled-headed nut and washer.

Method of Fitting and Using the Apparatus.

The expanding frame is placed over the rear end of the 1-inch

barrel and secured by two nuts. The apparatus is then placed in the gun, the inner edge of the flange of the expanding frame engaging with the muzzle face of the gun, and the 1-inch barrel projecting from the muzzle. The apparatus is fixed in the gun by turning the nut on the front of the expanding frame to the right, by means of the wrench provided for the purpose, the axes of the 1-inch barrel and the gun will then coincide.

The 0.23-inch aiming tube "D," is fitted in the 1-inch barrel by placing the chamber bush in the chamber of the 1-inch barrel and retaining it by means of the cartridge extractor; the 0.23-inch tube is screwed into the bush from the muzzle and secured by a nut and washer.

Elevation is obtained by means of the gun sights, and any error in line will be corrected by use of the deflection scale.

Care and Preservation.

All actions and parts of the rifle and tube should be kept perfectly clean and oiled, so as to keep them in good working order and prevent rust. No cutting material, such as emery cloth, is to be used for cleaning.

Ammunition used (see page 33).

CARRIAGES AND SLIDES.

| Nature. | Elevation in degrees. | Depression in degrees. | Height of axis in firing position. | Weight. | Diameter of trucks. | | |
|--------------------------|-------------------------|------------------------|------------------------------------|------------|---------------------|--------------------------|--|
| | | | | | Front. | Rear. | |
| <i>Carriages.</i> | | | | | | | |
| Case-ordwarf (Mk. I) | 10 | 5 | ft. ins. | tons. cwt. | ins. | ins. | |
| mate { low (Mk. II) .. | 10 | 5 | .. | 2 11½ | .. | .. | |
| Mk. III.. .. | 15 | 5 | .. | 3 7 | .. | .. | |
| Small port | 9 | 4 | .. | 3 0½ | .. | .. | |
| | | | (see slide) | 6 0 | .. | .. | |
| High angle { Mk. III.. | 20 to 70 | 5 | 6 6 | { 16 13½ | .. | .. | |
| { Mk. IV.. | 20 to 70 | 5 | | { 17 9½ | .. | .. | |
| | | | | | | Rollers, carriage, No. 7 | |
| <i>Slides.</i> | | | | | | | |
| Casemate | rear | .. | 4 2½ | { 4 15½ | { 10 | 13 | |
| | side | .. | 4 2½ | | | | |
| | { to work within length | Mk. I | .. | 4 2½ | { 4 17½ | { 18 | { Spitbank Fort. Horse, Sand and No Man's Forts. |
| | | Mk. II.. .. | .. | 4 2½ | | | |
| | | special.. .. | .. | 4 11½ | | | |
| Dwarf | Mk. II | .. | 4 2½ | 5 4 | 18 | 18 | |
| | { "A" { rear | .. | .. | 6 0 | 6 14½ | 18 | 24 |
| | | side | .. | .. | | | |
| | { "C" { central | .. | .. | 6 0 | 7 0½ | 24 | 24 |
| | | side | .. | .. | | | |
| { "D" { | .. | .. | 6 0 | 7 1 | 24 | 18 | |
| | | .. | .. | 7 19½ | | | |
| 7-foot parapet { Mk. I.. | .. | .. | 6 2 | 8 12½ | { 24 | 24 | |
| | { Mk. II .. | .. | .. | 6 0.15 | | | |
| Small port | .. | .. | *4 6½ | { 5 6 | 13 | 13 | |
| | | | +5 6½ | | | | |

* Least height.

† Greatest height.

Carriage, Garrison (Casemate or Dwarf).

(Plates II and III.)

The carriage consists of two wrought-iron double plate brackets, connected by two transoms and a bottom plate. The brackets are made by rivetting an iron plate to each side of a wrought-iron framing.

A bracket is fixed to the front of the bottom plate for the attachment of the buffer piston-rod, and two clip plates are bolted to the sides to prevent the fore part of the carriage jumping when the gun is fired.

Marks to indicate, when muzzle of gun will clear parapet (maximum elevation and depression), and when gun is in loading position, will be put on locally where required.

Running-Up Gear.

The carriage is fitted with front and rear rollers and an eccentric shaft for "running-up" and "back," which is effected by levers inserted in sockets fixed on the end of the eccentric shaft. For "running back" the double block of a special tackle is connected to the centre bearing of the eccentric shaft, and the running end passes round a bollard turned by gear on the slide.

Elevating Gear.

The elevating gear consists of a worm shaft gearing into a worm wheel, which by means of two spur pinions actuates an elevating arc pivoted to the breech of the gun. Similar sets of this gear are fitted to each side of the carriage, and can be worked together or singly. In the latter case the worm shaft not in use must be pushed out of gear and secured by a pawl fitted for the purpose.

In the latest pattern of elevating gear the worm wheel is recessed out to fit a friction cone which is keyed on to the elevating spindle. This cone is adjusted by nuts to allow a certain amount of slip which will prevent damage to the gear when firing.

Casemate Slides.

(Plate II.)

The slide consists of two girder sides connected by five transoms, a top plate, and two truck plates with truck brackets and trucks.*

Hydraulic Buffer.

The compression hydraulic buffer is fixed to the rear transoms by holding down brackets. It consists of a wrought-iron cylinder* with a piston-rod and piston. The cylinder is closed at the front by a wrought-iron cover and flange, and at the rear by a wrought-iron cap. A stuffing-box is formed in the cover for the packing, which is tightened up by a metal gland. The cylinder is 7-ft. 3.5-in. long and 8.07-in. diameter; the piston is 8.04-in. in diameter, and has four circular holes each 0.8-in. diameter. The quantity of oil required to fill the buffer is 12 gallons.

* In future the trucks and buffer cylinders will be of steel.

When the carriage is "run up" the piston is drawn up close to the front cover. On firing the gun the velocity of the piston is resisted by the fluid, which can only pass through the holes, and thus absorbs the recoil.

These buffers have a tendency to expand and allow violent recoils. When such is the case an adjuster is fitted to the piston, and a strengthening band is made to grip the buffer by means of a wedge. The adjuster is constructed to close or open one of the holes in the piston to any desired amount by a screwed plug.

A zinc pan to catch the drip from the gland is suspended in front of the buffer. It is only used in casemates.

Traversing and Running Back Gear.

The "traversing and running back gear" consists of a combination of common tooth gearing, which acts directly on the two rear trucks of the casemate slide, and traverses it right and left as desired. The gear is actuated by a winch handle.

The "running back" gear is part of the traversing gear, combined with a revolving bollard and special tackle, consisting of two double blocks; one is fitted on the rear of the carriage, and the other on the rear of the slide, with a fall of rope, the running end passing round the bollard.

These gears are worked independently by means of a clutch pinion which connects or disconnects them as required.

Rear Gear.

"Rear gear" slides are worked from the rear with one winch handle.

Side Gear.

"Side gear" slides are worked from the side by two winch handles on a cross shaft in rear of the slide.

Gear to Work within Length.

Gear "to work within length" is similar to the side gear, but the cross shaft is fixed sufficiently far forward to prevent the winch handles projecting beyond the rear of the slide or its fittings.

Central Gear.

"Central gear" is similar to that for "working within length," with the cross shaft fixed nearer to the centre of the slide, and connected to the rear gear by a short longitudinal shaft.

Fittings.

The slide is fitted with brackets for the side arms and iron-pointed levers, and a water tank for the sponge head. A pointer is attached to the rear of the slide which points to a graduated arc let into the floor of the work to indicate the angle of traverse.

Dwarf Slides.

(Plate III.)

The dwarf slides are the same in general construction as the casemate, but are of greater height, this being obtained by the insertion of plates and packing pieces between the truck brackets and the side girders, and by the increased diameter of the trucks. The fittings

are the same as for the casemate, with the addition of steps which are hooked on each side.

The traversing gear for the Dwarf "A" is similar to that for the casemate.

In the Dwarf "C" the front and rear trucks on the left side are geared together by a longitudinal shaft with bevel wheels and pinions, and are worked from the centre or side by a cross shaft.

In the Dwarf "D" the front trucks are geared, and are connected by a shaft to the gear at the rear of the slide.

Carriage, Garrison, Casemate low (Mark II).

(Plate IV.)

This carriage is constructed with low side brackets, and the bottom of the carriage is formed into a well which fits between the slide girders and allows the gun to be elevated at the requisite angle. In other respects it is generally similar to the casemate or dwarf carriage, but the fittings are not interchangeable.

Slide, Casemate, Mark II.

(Plate IV.)

This slide is made higher than the Mark I to compensate for the lowness of its carriage, and the distance between the girders is 4-ft. 1½-in. to suit the well. The hydraulic buffer has to lie low between the slide girders, and it is supported at the rear by a solid forging bolted beneath the bottom plate.

Mark II "special" slides are the above slides made 9-in. higher to suit the Spitbank Forts. This is effected by the insertion of side stays above the truck brackets and by increasing the diameter of the rear trucks. Fifteen of the first pattern have been made of this height by the addition of 9-in. packing pieces between the girders and truck plates, the existing trucks being retained.

Carriage and Slide, 7-ft. Parapet, Mark I.

(Plate V.)

The carriage is the casemate and dwarf carriage fitted with two loops for the guide ropes of rammers.

This slide is the Dwarf "C" with a loading stage and derrick fixed to the front, and the traversing gear rearranged, so that the mounting can be loaded and traversed from a sunken way.

Loading Stage.

The loading stage consists of two iron girders bolted to the front of the slide, on the top of which a wood floor is laid. Two steps are fixed to each side, and four stanchions with hand-rail at the front.

Two steel derrick brackets are fixed to the front of the slide (one at each corner) in which the pillar of a loading derrick revolves. The derrick is hinged to the pillar, so that it can be folded down under cover. The top of the pillar is fitted with a catch to fix the derrick in position while loading, and a check chain to prevent it falling too far when not in use. The derrick bracket is fitted with a joint for the snatch block of the loading tackle.

Traversing Gear.

In the traversing gear the cross shaft and short longitudinal shaft are removed, and the gearing at the rear slightly modified and supported by a long bracket so that it can be worked by a winch handle from the sunken way.

Carriage and Slide, 7-ft. Parapet, E.O.C.

A few of the conversions to 7-ft. parapet mountings have been made from those of E.O.C. design. This design differs from the R.C.D. chiefly in the height of the carriage and the shape of the slide girders, which are not "fish-bellied," but are similar in form to those of the 9-in. slides. The difference in height admits of the use of 18-in. trucks. The sighting step is 1-ft. above the rear of the slide, where it is supported by three iron stays, and is reached by two ladders, one on each side of the slide. This mounting is furnished with two hand posts, one at each end of the step.

The principle and arrangement of the gears are the same as those for the R.C.D. design, but the details of the fittings vary to suit the difference in the contour of the mountings.

Carriage, Garrison, Mark III.

(Plate VI.)

This carriage is a conversion from the casemate or dwarf carriage, and is arranged so that the gun may be fired at an elevation of 15°. For this purpose the side brackets are increased in length and the bottom plate is cut away for the gun to clear at high angles of elevation.

The elevating gear is of the ordinary worm-wheel type fitted with a frictional cone arrangement, but the arcs are made longer and run between two metal guides, and a stop is fitted to the bottom plate to limit the elevation to 15°.

Slide, 7-ft. Parapet, Mark II.

(Plate VI.)

This slide is a converted dwarf slide fitted with two hydraulic buffers in compression and with a box girder in the front to take the downward thrust of recoil when firing at high angles of elevation. This box girder is fitted with an arrangement of disc springs attached to the front truck (this slide has only one front truck) to keep the girder off the racer when traversing. On firing the springs are compressed and the box girder takes a bearing on the racer and thus relieves the truck axle of the downward pressure.

The compression buffers are fixed along the girders at the rear of the slide; they are fitted with taper bars which gradually close apertures in the pistons to give an approximately constant pressure during recoil. The area of the apertures may be altered by turning the piston-rods through an angle so that the resistance to the flow of the liquid may be adjusted to suit varying charges. The piston-rods are connected to the carriage by brackets, and are turned by means of a connecting bar to which they are attached by short levers. A graduated scale is fitted to the front transom of the carriage to indicate the adjustments.

A fixed loading stage and rear gear for sunken way, of similar design to that for the Mark I, are fitted to this slide. The pivot block and bedding for the racer are in one large casting.

Hand-post and Sighting Steps.

A hand-post and sighting steps are fitted to the rear of each slide to facilitate firing at moving objects. These fittings will form a standing place for the gun layer, where he will be safe during the recoil of the carriage, and from which he can look over the sights and signal to the gun captain when he is on the object to be fired at.

TRAVERSING ARCS.

The arcs are of metal, cast with figured graduations, and are of two patterns. The 1st pattern is graduated from 0° on the left, to the greatest possible angle of traverse on the right, for open batteries; but in casemated batteries they are so graduated that when any two guns are parallel, their pointers will indicate the same graduations. In both cases the zeros are on the left, and so placed as to indicate the extreme right-hand line of fire of the battery.

The 2nd pattern differs from the 1st in being made in two sections, with the graduations on one section and the figures on the other. This system renders the half and quarter degrees more distinct, and enables the zero line on the arc, which in all new works (casemate or otherwise) will be in the direction of true north, to be truly laid, and the figured section to be arranged to correspond. Slides mounted in works furnished with this arc will be fitted with a new pattern pointer, as shown at A, Plate V.

RACERS.

The racers are of steel, and, with the exception of "A" pivot rear racers, are bevelled on their upper faces to suit the cone of the trucks. In section the racers are formed with a broad bottom flange having a rib rising in the centre which tapers towards the top.

A stop in the form of a $\frac{3}{8}$ -in. screw with a head 1-in. in diameter and 1-in. high is screwed in the end of the racer to prevent the slide running off.

RADI OF RACERS.

| Pivot. | | Front. | Rear. |
|--------|-------|-------------|---|
| "A" | | 8-ft. 0-in. | 18-ft. 0-in. dwarf casemate and small port. |
| "C" | | 5 " 8 " | 5 " 8 " } |
| "D" | | 3 " 0 " | 3 " 0 " } dwarf. |

SMALL PORT CARRIAGE AND SLIDE.

Carriage.—The carriage is arranged to allow of the gun being raised vertically through a height of 12-ins. by means of a hydraulic lift, or ram, acting under the trunnion coil, so as to enable an elevation of 9° and a depression of 4° to be obtained through a small port.

The gun rests in movable trunnion blocks, which are free to move vertically in recesses formed in the carriage brackets. The trunnion blocks are supported by vertical screws, to which motion is imparted, through toothed wheels and shafting, by means of winch handles to the rear. The screws are worked so as to follow up the trunnion blocks when the gun is lifted by hydraulic power, as it is intended that they, and not the hydraulic ram, should support the gun when fired. They also serve as an alternative means of lifting in the event of the hydraulic gear being deranged.

The hydraulic ram, for raising or lowering the gun, is placed centrally in the carriage and in the vertical plane of the trunnion blocks.

The ram, with its cistern and pump in one is supported on the bottom plate of the carriage by movable plates, which admit of its being removed when necessary. The pump is worked by a lever on each side of the carriage, and the ram is lowered when required by raising the rear ends of the pump levers above a folding stop on the bracket.

The elevating gear is similar to that of the Mark I carriage, but is attached on the outside of the carriage. The worm-wheels are each fitted with a cone friction clutch. A straight rack is used instead of an elevating arc, and is connected to the gun by a link. An index and pointer are fitted on the left bracket of the carriage and show the elevation and depression that can be given to the gun at any point of the vertical lift.

Slide.—The slide is of the same description as the 10-in. casemate slide, but it is raised 6 inches by the introduction of packing pieces; two hydraulic buffers at the sides are used, instead of one at the centre, so as to clear the hydraulic ram during recoil.

CARRIAGE, GARRISON, R.M.L., 9 AND 10-IN., HIGH ANGLE, MARK III.

(*Plates VII and VIII.*)

The mounting is built up of steel and is constructed to allow of firing at high angles of elevation from 20° to 70° ; the loading position is 20° elevation. It is capable of giving 5° depression to enable the gun to be depressed when not in action, but it is not to be fired below 20° elevation.

It consists of a cradle and under-carriage, the whole being mounted on a live roller ring. The cradle carries the gun which recoils within it. It is fitted with two pairs of cylinders on the hydro-pneumatic principle, the recoil rams being fitted to the gun by means of brackets. It is mounted in the under-carriage on trunnions, and is so arranged that the gun recoils in the direction of its axis at any angle.

The cradle (*a*) is in two pieces bolted together, each half containing a pair of cylinders. The lower cylinders (*b*) in which the rams (*c*) work are of metal and contain liquid, the upper cylinders (*d*) being of steel and containing compressed air. The upper and lower cylinder on each side are connected by a rear cap (*e*), which has a filling cock (*f*) for the passage of the air and liquid, a water-level cock (*g*), and a cut-off plug (*h*). There is also a recoil valve in each rear cap, and it is so arranged that it can be adjusted to regulate the recoil. On firing, the liquid is forced by the ram past the recoil valve into the air cylinder, thus further compressing the air in it. A small passage which is always open between the two cylinders allows the fluid to be forced back by the compressed air after recoil, and this acting on the base of the ram returns the gun to the firing position. The air and water cylinders on either side are connected together by two pipes to equalize the air pressure, and to maintain one level for the liquid. The lower pipe for liquid is fitted with a draw-off valve for emptying the cylinders.

The cradle is supported in the carriage by ball bearings which reduce the labour of elevating or depressing. The casings (*i*) in which the balls rotate are supported by screws and disc springs; on firing, the springs are compressed, and the shock of recoil is taken up by the trunnion bearings of the carriage, the balls being relieved by the springs.

The under-carriage (*j*) consists of a circular platform with two side brackets to take the trunnions of the cradle. An upper roller path (*k*) is fixed to the underside of the mounting, and is placed (not fixed) on a live roller ring, consisting of two steel rings secured to each other by rivets and collars, and carrying 16 "rollers, carriage, No. 7," attached to it by spindles. The ring is mounted on the lower roller path or racer (*l*), which is secured by bolts and plates to the concrete of the work. Front and rear clip plates of steel are bolted to the platform and engage a rim formed on the racer.

The elevating gear is fixed to the front of the carriage. It consists of two hand wheels (*m*), one on each side of the cross shaft, in the centre of which is keyed a mitre wheel which transmits motion through a similar wheel to a worm which gears into the elevating arc (*n*) attached to the cradle. An elevation indicator is fixed at the right side of the carriage. It consists of a metal arc graduated in 60 divisions, each equalling 1 degree, figured to show elevation from 20 to 70 degrees; and a steel pointer with a vernier on its lower end, graduated in 11 divisions, each division representing 5 minutes of elevation. The pointer is attached to the cradle trunnion.

Traversing is effected by two distinct gears of the same pattern, one on each side of the carriage. Each gear is worked by a hand wheel (*o*), which transmits motion through bevelled wheels to a vertical shaft (*p*), at the lower end of which is a pinion to gear into a traversing rack fixed round the lower roller path. Metal arrow plates indicate the direction of traverse. A metal traversing arc is fixed to the floor of the work, and the degrees of traverse are indicated by a pointer (*r*), which is bolted to the front of the under-carriage.

With each carriage is issued a loading trolley, consisting of two bogies, each with four trucks. The trolley has an angle of 20° to suit the loading position of the gun. The projectile is held on the trolley by a projection which is forced up to its work by a spring during transit from the magazine. On raising a lever, the projection is drawn away from the projectile, which is then free to be rammed home.

CARRIAGE, GARRISON, R.M.L., 9 AND 10-IN., HIGH ANGLE, MARK IV.

This carriage is generally similar to the Mark III, differing principally in the lower carriage being of cast-iron. It consists of two bracket sides, front and rear transom, all bolted together; a cast steel bracket is bolted to the front transom for the elevating gear.

"PUMP, AIR, DOUBLE, MARK I."

(Plates IX and X.)

The pump is intended to charge the recoil cylinders of disappearing garrison mountings with fluid or compressed air.

It consists of two gun metal cylinders (A and B, Plate IX), of different diameters, in one casting, with a base plate, on the top of which an iron frame is bolted to form a tank (C) for the fluid while being pumped into the recoil cylinders. The pump cylinders are fitted with plungers (D) actuated by a rocking lever (E), which is supported on brackets (F) rivetted to the tank.

The pump is in duplicate, and is bolted to an iron bedding plate (G), which is secured to the floor by clips (H) and cotters (I). It is

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worked by two T handles, which are attached to the rocking levers, and are connected at the top by a link to insure uniform action.

When charging the recoil cylinders with fluid, the fluid is drawn through suction valves from the tank into the large pump cylinders (A), and on the down stroke of the plunger is forced into the small cylinder through delivery valves. When charging with air the connection between the tank and the cylinders is cut off by closing the valves (a) near the copper delivery pipes, and the air is drawn through a suction valve at the bottom of the large cylinder. This valve is never cut off, but is more heavily weighted than the water valve, and when the water passage is open liquid is drawn in in preference to air, provided the strokes are not too jerky.

Either pump can be disconnected if necessary, and worked independently; the delivery of either is cut off by closing the delivery valve. When this is closed, of course, the handle must be disconnected, so that the pump cut-off may not be worked.

The pump should be kept in store with the tanks full of liquid, and so used whether air or liquid is being pumped.

To keep the leathers in good order they should be slightly under pressure. To obtain this screw one length of the copper tubing on the delivery nozzle (J), and on to the other end of the tube fix the blank cap (with packing leather). Then work the pump with the water valves closed until it becomes difficult to move the handles, when the pump may be left—the air in the tubing serving to maintain the pressure obtained.

When standing long in store, the pump should be tried occasionally, to see that the pressure is still on.

RESERVOIR*, MARK II, AND SEPARATOR.

(Plate XI.)

The reservoir is for keeping in reserve a supply of compressed air for re-charging the cylinders of H.P. mountings. It is in the form of a flask, with a short neck at one end, fitted with a stop-cock (a) for charging and discharging the reservoir; a projection (b) on the cock is screwed to take the nut of the charging pipe. The stop-cock is in two pieces, so that the pressure in the reservoir can be cut off, and the outer part removed when the reservoir is packed for transport.

The pressure in the reservoir should not exceed 2,000 lbs. on the square inch.

In order to absorb the carbonic acid gas, and thus prevent the deterioration by rust of the interior of the reservoir, 3 oz. of a 10 per cent. solution of caustic soda will be poured into it before each occasion of charging. The solution remaining from the former occasion should first be emptied out.

The caustic soda solution is issued in pint bottles. It should be kept closely corked.

The separator is to separate the moisture from the air during the process of pumping into the reservoir. It consists of a copper tube, 1½-in. in diameter and 3-ft. long, screwed at both ends. At one end of the copper tube a wrought-iron head (c) is fitted, furnished with inlet and outlet valves of gunmetal, and a ½-in. copper pipe (d), which carries the air and water in a downward direction into the separator.

* The Mark I reservoir is not so strong as the Mark II; it is not issued for service with these mountings.

At the other end of the copper tube is a wrought-iron foot which is fitted with a drain-cock (*e*) of gunmetal. The separator is connected up between the pump and the reservoir, and the moisture of the air, while passing through the copper tube, falls to the bottom and is blown off from time to time during the operation through the drain-cock. When the separator is used, it must be always fixed in vertical position, the inlet and outlet valves being at the top.

Care and Preservation, *see* page 29.

INDICATOR PRESSURE, SPRING.

(Plate XII.)

The indicator shows the pressure per square inch in the recoil cylinders of H.P. mountings.

It consists of a metal cylinder (*a*) screwed into a metal casing (*b*) which contains a steel spiral spring, and on the exterior of which is fitted a dial (*c*). At the lower end of the spiral spring is a piston which works in the cylinder, and is connected by a small chain to a drum, on the spindle of which is fitted a pointer (*d*). A flat steel spring is wound around the drum, and fixed to it, so as to cause it to revolve directly the chain is slackened.

The pressure acting on the piston, overcomes the resistance of the spiral spring in proportion to the pressure obtained; this movement slackens the chain, and allows the flat spring to turn the drum with the pointer (*d*), which at once indicates the pressure on the dial (*c*). This dial is graduated to record from 0 to 2,000 lbs. per square inch.

The packing for the piston is special; it consists of finely shredded asbestos fibre, mixed with tallow, and pressed into a recess in the bottom of the piston, by means of a rammer supplied for that purpose. Spare packing is issued in a brass box.

The indicator with the necessary spanners, packing, and instructions, is issued complete, packed in a wooden box.

CONNECTION, INDICATOR, PRESSURE.

(Plate XIII.)

The indicator is attached to the recoil cylinder of the mounting by the intervention of a three-way connection, one opening of which (*a*) screws into the filling cock, the opposite one (*b*) takes the pump tube, and the centre (*c*) the indicator. (When the indicator is not on this opening it is closed by the closing plug (*f*), the nut (*h*) fitting either the plug (*f*) or the foot of the indicator.) There is a cut-off (*d*) worked by the spindle (*e*), which closes the way to the indicator, while leaving the passage free between pump and cylinder. The way to the indicator should not be left open while pumping or firing is going on, as the indicator is liable to suffer. When it is desired to leave the indicator on, and detach the pump pipe, the bared nozzle of the connection is closed by a blank cap (with leather washer), supplied.

In connecting the indicator it is not necessary that it should be absolutely vertical, an inclination of 10° or 15° is admissible.

The indicator is issued in a box with two spanners.

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GAUGE, PRESSURE, DEAD WEIGHT TESTING.

(Plate XIV.)

This is issued to test the accuracy of the indicator records.

The indicator is screwed on to the connection at one end, and fluid pressure applied by means of a plunger (*e*) driven by a hand-wheel (*f*) at the other end. A safety valve, weighted by means of a lever (*g*) which supports marked weights (*h*), rises when the pressure per square inch marked on the weights is obtained; the indicator (*c*) should then show this pressure. The lever bed plate, &c., for the weights, counts for 200 lbs. (per square inch) in addition to the weights applied.

The liquid employed is the same as that used in H.P. cylinders, and it is poured into the reservoir (*i*) from time to time as required. There are two cut-off valves (*k*) and (*l*), one to the indicator and one to the reservoir. As the stroke of the plunger is small, the liquid has to be drawn from time to time from the reservoir without losing the pressure, and this is effected by the judicious manipulation of these valves, the indicator being cut off by screwing up the valve (*k*) and the reservoir connected when the plunger is being withdrawn, and the reservoir cut off by the valve (*l*), and indicator connected when the plunger is being screwed in. The reservoir should be kept covered while in use to prevent dust getting into the liquid.

Care should be taken not to shake the instrument while the pressure is on, as it is liable to make the safety valve act prematurely, and so vitiate the results.

There are several leather joints and packings which require attention. Spare leathers are issued in a small tin box in the case, together with the necessary spanners, and special instructions as to packing the piston, &c.

LIFT, MUZZLE, HYDRAULIC, RAISING PROJECTILES.

(Plate XIVa.)

This lift is for use in casemates, in raising projectiles from the projectile barrows on the gun floor to the muzzles of the guns.

The lift comprises the following principal parts:—

1. Cylinder, with ram, gland, and bush.
2. Arm, supporting.
3. Arm, radial.
4. Tray, projectile.
5. Casing, valve, with valves, shaft, and foot levers.

The cylinder, which is sunk vertically into the floor of the emplacement, under the muzzle of the gun, is fitted with a telescopic ram, a ram gland, and a bush. The ram is formed at the top end to receive the supporting arm, and is fitted at the bottom end with a leather pad. The ram works through the gland and the bush, the latter serving to support the ram when fully extended. The supporting arm is keyed to the top of the ram, and carries on its outer end the radial arm, to which the projectile tray is attached. The radial arm is pivoted to the supporting arm, and thus admits of the projectile tray being moved in any direction within the total length of the two arms. The arms are of sufficient length to admit of the projectile tray being brought in front of the muzzle (when the gun is in the loading position) at all points of traverse; they also facilitate the entry of the projectile

into the bore, as they allow of the tray being moved a short distance backwards or forwards, in a line with the axis of the bore. The radial arm and projectile tray work on ball bearings.

A casing, containing a pressure valve and an exhaust valve, is fixed at the side of the emplacement near the port. The valves are actuated by means of foot levers, of which one is attached to each end of a shaft, which reaches across the port. On a foot lever being pressed down the pressure valve is raised, allowing the pressure water to pass into the cylinder, where it acts on the ram and raises it; on releasing the foot lever the valve is pressed down by a spring, thus cutting off the pressure. On the foot lever being raised the exhaust valve is opened, and the ram descends by its own weight.

The hydraulic power is supplied from an accumulator through a system of pipes laid in the "work."

CARE AND PRESERVATION OF MOUNTINGS.

(a) *Extracts from "Regulations for Magazines and the Preservation of Artillery Matériel."*

(a) *General Instructions.*

"534. A 'Memorandum of Examination,' Army Form G 835, is issued with each land service . . . R.M.L. mounting with hydraulic buffer or hydro-pneumatic cylinder. It is intended to preserve a complete history of the mounting and record of all rounds fired from it, and will be kept by the officer in possession of the mounting.

"535. Any repairs to the mounting, or alteration due to change of pattern, must be recorded on the memorandum, with the dates when executed.

"536. The number of rounds, including blank charges, fired from each mounting will be entered by the officer in charge at the conclusion of each day's practice, so that an accurate record of the firing may always be kept.

"537. The result of any examination will be added by the inspecting officer or examiner who performs the duty, and the rounds totalled up to each date.

"538. A report of the entries made is to be sent to the Chief Inspector, Woolwich, through the C.O.O., on Army Form G 832, on completion of repairs, erection, removal, or alteration of the mounting, quoting authority. An annual report of rounds fired will be sent to the Chief Inspector, Woolwich, on Army Form G 874, by O.C.R.A.

"539. If at any time the Memorandum of Examination be lost or damaged, a duplicate can be obtained from the Chief Inspector, Woolwich, by whom also inside sheets for continuation of the records will be supplied on application.

"540. In all correspondence and reports relating to carriages and slides, their exact natures, marks and register numbers should be quoted.

"541. Care must be taken that carriages and slides of every description are kept in working order. This is specially necessary for iron or steel parts, which are liable to deteriorate owing to rust, and the working parts will become so corroded as to induce irregularity in action, and will be difficult to work. Particular attention will be paid to the following instructions.

"542. All carriages, slides, and stores connected therewith, forming the armament of fortresses, will be cleaned and painted biennially; but should they when mounted on the sea faces of works be found in a bad state from exposure to the spray of the sea, or when in casemates from the damp and dripping, they will be cleaned and painted every year, and oftener if considered necessary by the O.C.R.A.; on this point, considered as a question of expense, a sound discretion will be exercised.

"543. Before the re-painting of carriages, slides, they will be examined and thoroughly overhauled by the armament artificers under the Inspector of Ordnance Machinery when there is one in the district.

"544. If the paint is rubbed off any part of the mounting, the place should be patched over as soon as possible to prevent rust.

"545. In batteries accessible to the public, where no permanent protection is possible, or in works where mountings are not frequently used, all detachable fittings and movable parts of the elevating and other gears will be removed and placed in store, where the bright parts of the iron work will be well coated with grease to preserve them from rust. These parts will be thoroughly cleaned and placed in position, at least once in three months, to see that they are in proper working order. All other gears should be worked once a week to ensure their being in a working condition.

"546. In all batteries, when guns or mountings are being overhauled, or dismantled for repairs, all parts, &c., of a portable nature, which are not necessarily required for the purpose of immediate continuation of work, must be placed in the Artillery Store, or other suitable place, for safe custody.

"547. A thorough cleaning and lubricating of all standing working parts must take place once a month, all clotted grease being removed where visible, by scraping, and the parts wiped with an oily rag. Mountings much exposed and liable to accumulate dust or sand, should not be left with much grease or oil upon them, but only sufficient to prevent rust, for which a very slight film will suffice. Special care must be taken to prevent grit from getting on the bearing surfaces between the cradle and the gun of H.A. mountings.

"548. Whenever and wherever fresh lubricant is applied, the old should first be wiped or scraped off, and the parts well worked to distribute the fresh lubricant before leaving them.

"549. The gear under the slide will be examined as to condition by a man lying on his back while the slide is traversed above him.

"550. It has been found, especially in exposed positions, that a hard glassy cake of oil and sand, &c., will sometimes form on the slide, and being of a semi-transparent nature, it is liable to escape observation, and induce violent recoils from the very slippery surface it presents. Such a skin has to be hammered off; its formation is best guarded against by leaving as little oil on the sliding surfaces as possible when not in use.

"551. When not in use, the position of the carriage and slide will be frequently changed, to prevent impressions on the rollers, trucks, and racers, and to keep the sliding faces clear.

"552. During practice, the top of the slides of mountings not on live rollers should be occasionally rubbed with a slightly oily cloth to prevent seizure.

"553. Before firing or drill, care should be taken that all nuts and screws are properly tightened up; that all working parts are in proper

gear; and that all friction cones and brakes are accurately adjusted, and are not jammed. Particular attention should be paid to the clip plates, the bolts of which tend to stretch.

"554. A nut or screw should be slightly oiled before being entered, and a few turns given to it by hand before using the spanner, to prevent damage by the threads crossing. A burr on the threads of a screw will prevent it being screwed home, and should be removed. A hammer should never be used to tighten up screws or nuts.

"555. Particular attention will be observed when removing or adjusting any gear not to indent or damage the component parts by rough usage. A hammer should never be used unless with a piece of wood or brass to transmit the blow.

"556. Rollers and trucks, and their axles when accessible, will be frequently removed and properly cleaned and greased before being replaced. The front trucks are removed by running the carriage back and lifting the front of the slide by hydraulic jacks, sufficiently high to take the weight off the trucks; care will be taken to block up the slide before removing the axles. For the rear trucks, run the carriage up, place the jacks under the rear block plate, and proceed as for the front trucks.

"557. Particular care must be observed when replacing conical trucks that they are in the correct position, viz., with the smallest diameter towards the pivot.

"559. Racers should be scraped and cleaned and well greased at the sides where the truck flanges bite, to render traversing easy. The inner flanges of the trucks and all traversing racks should also be cleaned and well greased. In mountings without traversing racks the top of the racers should be kept free of grease.

"560. If the truck flanges bear against the racers so as to impede traversing, an error in the position of the pivot or pivot plate probably exists; this should at once be reported.

"561. Particular attention is to be paid to the accuracy of level of the racers—especially on sea fronts. There should be no alteration in elevation, as the slide is traversed from side to side. To ascertain whether this condition holds good, a spirit level should be placed on the mounting, which should then be traversed from extreme right to extreme left, and *vice versa*; the bubble should remain stationary throughout, and the mounting bear on all its rollers continually.

"562. The adjustment of the degree scales of index plates, traversing arcs, or elevation indicators, should also be checked. These should read at zero on the degree scale when the axis of the gun is horizontal. The horizontal position of the gun can be obtained by a spirit level resting on a straight edge in the bore or on the quadrant plane prepared on the breech of the gun.

"563. All friction cones, brake drums, and discs of friction clutches will be kept clean, smooth, and very slightly oiled to prevent seizing.

"564. Friction cones and clutches will be tightened up by means of the adjusting nuts, so as to allow a slight slip in the gear on firing.

"570. Iron-pointed levers and their sockets must never be oiled or greased, but simply cleaned to prevent rust.

"571. In lubricating, the lubricating holes will be cleaned out with a wire and filled with oil, care being taken to replace the small screws, the heads of which must be kept bright so as to be readily seen. After filling the oil holes, the parts should be worked backwards and forwards until the oil shows on the shafting, fresh applications of oil being made if necessary.

"572. One list for each nature of mounting, showing positions of oil holes, and how access is obtained to them, is to be hung up in a safe and convenient place in each work, and no holes must be neglected. These lists can be obtained on application to the Under-Secretary of State for War, the nature of the mounting being specified.

"573. The teeth of all pinions and toothed wheels should be greased.

"574. In all cases where guns are mounted on carriages and slides fitted for hydraulic buffers, the buffer will be kept on the slide filled with the proper quantity of oil, and the piston rod kept connected to the carriage; but in cases where guns are found to be especially hard to run back, and such guns are likely to be much used at drill, the officer commanding Royal Artillery may order the piston rods of such guns to be disconnected provided such instructions be given as will ensure proper precautions being taken to prevent the gun taking charge in running up.

"575. When works, however, are under repair, or persons other than the artillerymen actually in charge have access to places where guns having hydraulic buffers are mounted, the officer commanding Royal Artillery will use his discretion in having the buffers temporarily emptied, but they must be refilled as soon as possible.

"576. In cold climates, hydraulic buffers will be filled with service liquid composed of the following ingredients and in the proportions shown:—

| | | | | | |
|--------------------|----|----|----|----|------------|
| Methylated spirits | .. | .. | .. | .. | 7 gallons |
| Distilled water | .. | .. | .. | .. | 3½ " |
| Mineral oil | .. | .. | .. | .. | ¼ " |
| Carbonate of soda | .. | .. | .. | .. | 250 grains |

In case of necessity this liquid may be used in buffers anywhere, as a substitute for oil.

"577. The cylinders of hydraulic buffers should be emptied every 12 months, care being taken that the fluid is first well stirred up by moving the piston backwards and forwards; the fluid drawn off will be filtered, and if not then too thick may be used again. The cylinders will be cleared out every three years.

"578. The buffers should be carefully examined before firing or drill, to see that the cylinders contain the requisite quantity of fluid marked on the inscription plate: that there is no leakage at the glands and that the piston rods are properly connected.

"579. If a buffer leaks at the gland, and tightening up the latter does not stop the leak, the packing will be renewed. Materials for packing are detailed in Equipment Regulations.

"580. Any drippings of oil from the buffer, collected in the drip pans attached to the carriage or slide, should on no account be used on any part of the machinery of the mountings or any of the gun fittings.

"581. A copy of these instructions attached to a board will be hung up in each fort or battery where there are iron carriages. Copies for this purpose, printed on Army Form G 907, can be obtained on demand.

Scraping.

"588. Carriages and slides require scraping and cleaning, especially if mounted in open works, before proceeding to paint them, and all the old unsound paint, rust, and corroded oil or grease must be thoroughly removed. They must also be stripped of all their loose parts.

"589. The implements to be used in scraping are old swords, triangular steel scrapers, and scrapers made from old files.

"590. Scraping consists in going lightly over the surface with the scrapers, removing all blisters and loose paint, and forming a smooth surface for the new coat of paint. Care will be taken not to break into the old coat where it is found to be sound.

Painting.

"591. In repainting carriages and slides care will be taken not to paint any bearings or gearing parts: for instance, soles of trucks, teeth of pinions and wheels, the upper surfaces of the slide on which the carriage slides, the sliding surfaces of the carriage, &c. The carriages and slides will be thoroughly dry when painted.

"592. Racers, racks, soles of trucks, and pivots will not be painted, but will be rubbed occasionally with an oiled wiper, to prevent rust. Pivot blocks will be painted at the same time as the slides.

"593. The first coat or patching will be laid on lightly in those places which have been laid bare in the repairs, or by scraping. The stopping will be done after the first coat of paint has become set, as in the case of wood carriages.

"594. The second coat will be given after the stopping has been completed. It will be applied lightly, and carefully finished off.

High Angle and Disappearing Carriages.

"596. Constant attention should be paid to the care and preservation of these carriages, and officers having such in their charge should make themselves conversant with the mechanism and various details of the carriages.

"602. The carriage should be kept clean and examined each week. All axles, shafts, rollers, roller paths, bearings, and gearing will require periodical cleaning and lubricating, and should be kept free from burrs. Those parts which are issued bright should be kept bright, and not painted.

"603. The recoil cylinders will, if necessary, be emptied and cleaned out every 12 months, but if their general condition should warrant it, the period may be extended to any time within 3 years at the discretion of the G.O.C. The amount of dirt or rust should be noted. The liquid drawn off will be filtered, and if not then too thick may be used again.

9 and 10-inch R.M.L. High Angle Carriages, Marks III and IV.

"604. If the recoil cylinders leak at the ram glands, the glands must be tightened; if at the 'cap connecting cylinder' the cylinder must be tightened into the cap with spanner, No. 123, Mark II. To renew the hydraulic packing at the ram gland, first lay the gun horizontal, then retain it in that position, either by struts, or by securing the elevating gear, so as to prevent the gun from running back in the cradle. Then blow off the air pressure by opening the levelling valves, empty the buffers by opening the discharge valve; unscrew the glands, extract the defective packing, and replace by the new.

"605. To clean the recoil and air cylinders, first allow the air pressure to escape, and empty the cylinders (the liquid being drawn into pails through the discharge valve); then remove the glands 'inner,' 'outer,' and 'adjusting lift,' recoil valves, and the pipes connecting the air and hydraulic cylinders. Then thoroughly wash out the cylinders with water. A small hose, if available, will be found convenient for the purpose. Care must be taken that no grit is allowed to enter the cylinders or pipes.

"606. To fill the recoil cylinders, first lay the cradle level, with the gun up in the firing position, then slacken the air screws marked AA at front of cylinder, and pump in about $15\frac{1}{2}$ gallons of liquid at the supply valve C, closing the screws AA when the liquid flows from the openings. Pump in air until a pressure of 465 lb. per square inch is obtained, close the supply valve C, and lay the gun at 20° elevation, open the plugs BB, when, if the cylinders have been correctly charged, a spray of air and liquid will be obtained; if the spray is not obtained, liquid will be pumped in or run off as may be necessary to produce the spray.

"607. The recoil valves are for regulating the recoil of the gun, and care must be taken before firing to see that they are properly set; the normal lift of the valves is 0.2-inch. An index plate graduated* in 33 divisions (each division being equal to $\frac{1}{165}$ th of an inch of lift) is fitted to the "cap, connecting cylinder." On the inner gland is a line, which points to zero on the index plate when the gland is closed. To set the gland to allow of a lift of 0.2-inch to the valve, the line on the gland must be set to coincide with the 20th division of the index plate. The recoil measured on the ram should not exceed 21.5 inches for a full charge at the higher angles of elevation.

"608. If the outer glands, supply valve, or air screws are found to leak, they must be tightened; if this is not sufficient to prevent leakage, the leathers of the supply valve and air screws, and the lead washers of the outer glands must be renewed; to do this the pressure must first be blown off and the liquid withdrawn.

"609. The guides must be kept free from rust, and well oiled. The ball bearings must be lubricated with tallow, as oil will run away too quickly. When not in use the bearing screws should be slackened.

"610. When setting the gun on ball bearings, the bearing screws should be gradually screwed up, until the elevating gear can be worked freely by two men, care being taken that it is not screwed too high.

"612. An extract from these instructions, . . . attached to a board will be hung up in each fort or battery where high angle carriages are mounted. Copies for this purpose, printed on Army Form G 943, can be obtained on demand.

Hydraulic Gear.

"657. In an hydraulic installation care should be taken that the liquid used is clean and free from grit, sand, or other hard substance, that all valves are water-tight and work freely, and that all joints in pipes, glands, and stuffing boxes are properly packed and water-tight throughout the system.

"658. The liquid used is, in summer, a mixture of 50 lb. of soft soap to 1,000 gallons of water, and in winter a mixture of one part of glycerine to two of water. Both these assist to lubricate the working parts of the gear and to keep the leathers and packings supple. The object of the glycerine is to guard against the liquid freezing in the pipes.

"659. As an additional precaution, in positions liable to very severe frost, a stop valve should be provided in the suction pipe, and a small air valve between it and the pump, so that by shutting the stop valve and opening the air valve air can be pumped into the system, driving the water out of it through the exhaust main into the tank. In this

* In future manufacture the index plate will be graduated to 25 divisions.

case, however, the leathers and packings are liable to become dry, and it should only be resorted to in very severe weather.

"660. The supply tanks should always be kept covered to prevent the ingress of dust and dirt, and the suction pipe from the tank should have the end covered with fine copper wire gauze for the same reason. A very small particle of grit will cut the face of valves and cause a leak.

"661. When new pipes are required for any installation, they should be tested to twice the working pressure of the system of which they form part.

"662. When screwed glands are to be repacked, it is generally advisable to place a metal ring between the gland and the packing, to prevent the latter from being ground up and torn under the action of the screw.

"663. For low pressures, plaited cotton, soaked in paraffin wax or oiled, is sufficient to form a good joint in a gland, but where high pressures are dealt with, *i.e.*, above 750 lb. per square inch, it is advisable to insert a U leather first, with the open end inwards and supported internally by a metal ring, the ordinary cotton packing is then put over this and the gland screwed down.

"664. To repack a gland, the packing is to be inserted in the stuffing box in the form of rings with the ends cut square, the length of each piece being a little more than sufficient to meet round the rod to be packed. The ends of the ring are put into the box first, and the rest of the ring pushed in with a piece of wood. Care should be taken that the layers of packing "break joint" so that there will be no direct passage for the liquid to pass. After running a few hours the gland of a new joint should be tightened up.

"665. When a machine is in use, frequent adjustments of the gland become necessary to keep the joint tight. By over tightening the gland, however, an excessive amount of friction may be thrown on the rod which passes through it, and by this means the proper action of the gear may be interfered with.

"666. Leathers for glands, pistons, or other joints, when kept in store, should be free from dust and periodically smeared with dubbing to keep them soft and flexible.

"667. In inserting a new leather into a joint it is essential that it should be put in without damaging the edges, and great care must be taken that no dust is allowed to fall into the joint during its making.

"668. All leaks in valves or joints should be at once repaired, as they are likely to increase, and also to rust any surrounding gear that may be in the vicinity.

"669. When metal-faced valves are found to leak, the face and seating should be refaced, but this work should only be carried out by a skilled artificer.

"670. In case of a burst in any pipe, the pressure of water must be immediately cut off by the stop-valves, provided at various points of the mains for this purpose."

INSTRUCTIONS FOR REPLACING GEAR, &c.

Elevating Gear, Dwarf and Casemate.

The elevating gear is attached in the following manner:—

(a) The arc is pivoted to the elevating plate on the gun by the

pivot, which is marked "R" or "L" (right or left), and when screwed home a keep-pin is placed vertically through it and the plate. The top of each arc is marked "top," and must be placed accordingly.

(b) Pass spindles of pinions, 1st, 2nd, and 3rd motion, through the bracket, put on collars, and secure by nuts and pins.

(c) Place worm-wheel on 1st motion spindle, put on collar, and secure by nut. Care must be taken that the worm-wheels, which are right and left, are placed correctly in position, and the short boss of the wheel must be placed next to the pinion.

(d) Remove caps of worm-spindle bearings, open the pawl, place the spindle in bearings, secure caps and pawl.

(e) Place hand-wheel on worm-spindle, put on collar, and secure by nut.

Running up Gear.

To fit the running up gear to the carriage:—

(a) Place the front rollers in position by inserting the axles, and secure by keys.

(b) Place rear rollers on the axles, and rest them on the slide in rear of the carriage, raise the drop plates by removing the rear bolts of the two which secure them on each side, push the shaft with rollers evenly forward, keeping the eccentrics uppermost until the axles are fairly in the bearings, secure drop plates and lever sockets, and bolt on the socket to the bracket for running back block, to form the centre bearing for the eccentric shaft.

Traversing and Running-back Gear.

To fit the gear to a slide:—

(a) Remove the caps from all the brackets.

(b) Place the cross shafts opposite the brackets, the pinions being fixed; lift the whole into position, and secure the caps.

(c) Place the collar and clutch pinion on the bollard shaft, insert the end of shaft in the socket of bracket, and secure in rear bracket by cap and collar; pass spur wheel and bollard on to the rear end of the shaft, and secure by keys.

(d) Pass the double-pinion on the spindle gudgeon, and secure by collar and key.

(e) Place the pinion on the winch-handle shaft, and the shaft in the bracket bearings, key on the pinion, and secure cap and collar.

(f) Remove the guide bracket, place clutch lever so that the studs rest in groove of pinion, pass pin through lever and bracket, put on collar, and secure by key, refix guide bracket.

(g) Place the trucks in position, those with bevel wheels at the rear, gearing in the pinions of the cross shafts, insert axles, and secure by nuts.

(h) Place the blocks for the running-back tackle in position, and secure by giving a quarter turn.

(i) Place the cover over the double pinion, with bearings resting on winch-handle shaft, and secure by screws.

(b) Special Instructions.

To connect the piston rod.—Move the carriage to the rear sufficiently to enable a man to get to the bracket on the under side; remove the connecting nut from the piston rod, and draw the latter forward until its end projects through the hole in the bracket, keeping it central in the hole; screw on the connecting nut, and when quite tight take a half-turn back to allow a slight play of the bracket between the two nuts. Before connecting it to the carriage, the rod should be pushed

in and out to see that it works freely and that the packing gland is not too tight.

To Fill the Buffer.—Run the carriage up to the stops, take out the screw plug, and rest the gallon measure in the hole; turn off the cock and fill the measure to the mark, then turn the cock and allow the oil to run; repeat the operation until the required quantity is run in.

When firing with reduced charges sufficient oil should be withdrawn from the buffer to reduce the depth at the filling hole to 3-in. After practice the buffer is to be refilled.

To renew the packing, run the carriage up, empty the buffer, unscrew the gland, and extract the defective packing. Tallow well the new packing, insert it in the stuffing box, and tighten it up with the gland.

Shafts and spindles having nuts secured by taper pins will be marked to correspond with each other to prevent the nuts being placed on the wrong shafts or spindles. When necessary, nuts, shafts or spindles will be marked locally with a letter or punch mark as most convenient.

Whenever any parts are found broken, defective, or deficient, which cannot be renewed by the artificer, fresh parts should be demanded at once. Any damage occurring at drill or practice should be at once reported, with a view to its being made good without delay.

Small Port Mountings.

The hydraulic lift should be worked frequently, and a slight amount of pressure always maintained on the ram by pumping it up, to keep the packing leathers moist and in good condition.

The position of the following up screws should always correspond with the height of the gun, and great care must be taken before firing, to ascertain that the gun rests on the screws and not on the ram.

Any defect in the action of the pump is an indication that the packing leathers are not in order. In that case the handles must be rapidly worked for a short time, and if that does not answer the lift must be overhauled by a competent artificer.

The cistern must be drained every three months, and the fluid passed through a filter before refilling.

Reservoirs.

As the reservoirs have to sustain a high pressure when fully charged, and as the material of which they are made is liable to deteriorate through age, it is essential that they be periodically tested to ascertain if they are in a sound condition, and annealed to preserve the tenacity of the material. The testing will be carried out biennially at the respective stations by forcing in hydraulic pressure up to 2,500 lbs. per square inch in the case of Marks I and I*, and 3,700 lbs. per square inch in the case of Mark II. The outside of the reservoir near the centre must be accurately gauged at four points, both *before* and *after* testing, and the measurements recorded on a history sheet. Any reservoirs failing to pass this test, or showing any permanent set or leakage, must be returned to Woolwich. The reservoirs will be annealed every sixth year, for which purpose they will be returned to Woolwich. Each reservoir will have a register number stamped on it, also the manufacturer's mark, the numeral, the date of supply, and annealing and test marks with dates, as follows:—

| | |
|--------------|---|
| No. 56. | Filled reservoirs on R.A. charge should be marked |
| J. B. & Co. | with the word "filled" and with the amount of |
| II. | pressure in them. Care must be taken when |
| 1896. | removing reservoirs that they are not thrown down |
| (A) 10.3.96. | or roughly handled. To protect them from jar |
| (T) 11.3.96. | when being moved three rope grummets are placed |

on them, and in hot climates where it is necessary to protect them from the sun's rays, they will be covered by wadmiltits or such other suitable material as may be available.

A history sheet will be issued with each reservoir, on which must be detailed a complete history of the reservoir, from the date of its issue out of the Royal Arsenal, to its final return to store. The biennial tests and annealing will be recorded on this sheet (which must always be kept with the reservoir), and also anything calling for special remark.

The stamping on no account will be made unless the reservoir is empty.

TURNTABLES.

In certain positions where it has been found necessary to give to heavy guns, protected by armour, an extended range of lateral fire, a special type of casemate has been provided.

These casemates have curved armoured fronts, with two gun ports in each, and the gun is mounted on the service carriage and slide, on a large turntable, which is so constructed as to admit of the gun being trained through an arc of 60° at one port, and of being transferred to the other port, at which also it can be trained through a similar arc.

Each turntable consists of the following parts, viz. :

A strong circular platform, of girder work, varying from 20 to 23 feet in diameter, covered with a removable boarded floor, and carrying on its beams the gun racers.

Under the centre of the turntable is a massive casting, firmly secured to the masonry of the fort, and into this a strong central spindle passes through the platform.

The under surface of the platform rests, at its outer rim, on a set of conical rollers, hard cast iron, running in a live ring. The rollers travel on circular paths made of wrought-iron.

The circular path is held to the central casting already mentioned, by radial bars, and the live ring is confined to its proper circular movement by radial bars attached to a ring set on the central casting.

The turning of the table is effected by means of simple hand gear, working into cogs set on the outer edge of the turntable platform, a little below the level of the floor.

The whole of the turntable and the turning gear are contained in iron casings.

Tumbler stops, set in the floor, and worked by hand, engage with corresponding notches in the table when it is in the proper position to allow the guns to be worked.

One of these stops, also, when put in action, throws out the turning gear, and thus prevents any shock from firing being transmitted to the men at the handles.

A leather flap, attached to the outer edge of the turntable, and protected by steel strips, travels with it round the floor, and is intended to prevent any dirt from reaching the roller path.

The bushes of the central spindle can be lubricated by oil holes in the floor, and those of the rollers by oil holes in the inner faces of the latter.

All the bearings of the turning gear can be got at by removing the cover of the cast-iron casing in which it lies.

The principal points to be attended to in working are—

To keep the bearings of the machinery and the bushes of the turntable greased with lubricating oil, and the teeth of the wheels greased.

To keep all moving parts free from dirt and grit, and especially to keep dirt from falling down between the fixed and moving parts, and lodging on the rollers or roller path.

Never to fire the gun unless the turntable is locked by the stops. Neglect of this precaution would cause serious injury to the men at the turning handles.

For ordinary examination, the table should be revolved one-quarter turn every alternate day, or three times a week; lifting the floor, and lubricating the bearings as required.

Should it appear that more than usual force (three men) is required to move it, the table should be raised by means of the lifting gear supplied to each station, and the parts cleaned and lubricated as laid down for periodical examination.

Periodical examinations for purposes of extra cleaning, and of repair, when necessary, should be made every six months.

The turntable should be raised by the lifting gear to a sufficient height from the live ring (without dismounting the gun) so that the bushes of the central spindle may be thoroughly examined and cleaned, the spindles of the rollers of the live ring taken out, cleaned and adjusted, and all rust or dirt removed from the upper and lower roller paths and live ring.

The lifting gear consists of four long vertical screw bolts, supported at the upper ends by nuts resting on washer plates on the roof of the casemate, through which they pass, whilst their lower ends are secured to wrought-iron cross bars, inserted under the girders of the platform.

The nuts on the roof are provided with large spanners. These have two arms each, and each arm is capable of taking two men.

By working these nuts round the bolts, the table can be raised, but hydraulic jacks standing on the floor under the table, and bearing against the cross bars or washer plates, should be employed to assist the screws in lifting.

The lowering should be done by the screws alone.

Care must be taken that all the lifting bolts are equally tight to commence with, and that the nuts are turned simultaneously, and through precisely the same number of revolutions, both in lifting and lowering, and that they are not lifted from their seats by too quick a motion of the hydraulic jacks.

It will be found to be a safe and convenient plan to order a given number of turns of the roof spanners, say six for a spell, all the parties turning being halted at the end of each spell, and waiting for a fresh order.

The pinion of the turning machinery, which works into the cogs on the edge of the turntable, must be disconnected, and everything kept quite clear before commencing to lift. Care must be taken that the threads of the main screw bolts do not bear against the washers or sides of the holes through which the bolts pass.

The gun should be run back $\frac{1}{2}$ feet, so that the load may be divided uniformly among the bolts.

The screw threads should be liberally supplied with oil, and, when not in use, the gear should be kept under cover and clean.

Custody.

The turntables will remain in charge of the officer commanding Royal Artillery, who will undertake the moving of them, and such

lubrication as can be done by merely lifting the floor. The lubrication and cleaning of the turntable, its live ring and turning gear, which requires the turntable to be lifted, will be done by the Royal Engineers, the materials for lubricating, &c., being supplied by the Army Ordnance Department on requisition; the Royal Artillery officer in charge will be responsible that the requisitions are made in proper time, the Commanding Royal Engineer being responsible that the cleaning and lubrication are duly and most carefully carried out.

Repairs will be executed in the usual way by the Royal Engineers on requisition.

Detailed drawings are in the possession of the Commanding Royal Engineer at each station, who will place them at the disposal of the officer commanding Royal Artillery when required.

The quantities of oil, &c., for lubrication are given in the "Equipment Regulations."

AMMUNITION.

CARTRIDGES.

| Gun for which used. | Nature. | When filled | |
|-----------------------------|--|----------------------|------------------------|
| | | Length not to exceed | Diameter not to exceed |
| | | ins. | ins. |
| 10-inch, R.M.L. Marks | | | |
| I and II | 70 lb. P., full charge.. .. | 26.0 | 8.25 |
| | 44 lb. P., reduced charge .. | 17.3 | 8.25 |
| | 20 lb. 6 oz., cordite, size 10, with stick | 26.0* | 6.75 |
| III | 48 lb. S.P., full charge .. | 18.6 | 9.5 |
| | 14 lb. R.L.G. ⁴ , reduced .. | 11.0 | 6.6 |
| | 5 lb. " " " .. | 7.8 | 5.0 |
| I to III | 25 lb. blank, L.G., saluting .. | 14.0 | 8.25 |
| I and II | Aiming, { rifle, { electric .. { tube { percussion | over all | body base |
| | | 5.0 | 1.098 1.219 |
| | | 5.2 | 1.1 1.228 |
| | | 0.87 | 0.355 |

* Over stick.

All new cartridges for the guns are of silk cloth, hooped with silk braid; No. 2 class silk cloth being used for Marks I and II guns.

Some of the old serge cartridges may, however, still be met with; they are choked with worsted and hooped with blue worsted braid. They will be used up as far as possible before the silk cloth, except when firing blank, in which case silk cloth cartridges are *always* to be used.

The cordite cartridge is of No. 1 class silk cloth, sewn down the side and shaped to a cone at one end. A piece of silk braid, about 4 feet 6 inches long, is run through the small part of the cone at about 2.5 inches from the end, to secure one end of the stick to the cartridge. The cordite is placed round a stick of ash, 19.7 inches long, with a groove at each end, into which the cartridge is choked. An igniter, containing 8 ozs. R.F.G.² powder is sewn round the centre of the cartridge, the powder being arranged in six compartments by cross stitching.

Drill Cartridge.

The drill cartridges are a special manufacture made of wood covered with raw hide, and issued complete. Mark VI is shorter than previous patterns, so as to fit into the cartridge cylinder.

Cartridges, aiming-rifle, 1-inch, electric, for use with breech-piece having electric head.

The Mark II case is of solid drawn brass, having in its base an electric primer made of three tubes, which fit into one another, the central and intermediate ones being insulated from one another by means of goldbeater skin round the body of the former, and a vulcanized fibre washer under its head. A platinum-silver bridge, round which is a tuft of guncotton, connects the ends of the central and intermediate tubes, the space beyond the bridge in the intermediate and outer tubes being filled with fine grain powder. A conical brass plug closes the mouth of the inner tube to prevent the escape of gas. The head of the inner tube is raised in the centre to form a contact point, and round it is a ring of insulating material. The case is charged with 400 grains R.F.G.² powder, over which are placed wads, and a pointed bullet of hardened lead, secured to the case as for the percussion cartridge.

Mark IV differs from Mark II in having an electric primer consisting of a brass outer tube, two ebonite insulating plugs, and a brass contact pin. An aradio-platinum wire bridge is soldered, one end to the point of the contact pin, the other end to the circumference of the tube.

Cartridge, aiming-rifle, 1-inch, percussion, for use with breech-piece having percussion head.

Mark I, the case is of solid drawn brass, having the cap, chamber, and anvil formed in the base; the cap is double, the outer of brass, the inner of copper. Three fire holes in the cap chamber enable the flash to pass from the cap to the charge. The charge consists of 465 grains of M.G.¹ powder, or 400 grains R.F.G.², on top of which are placed wads, and the bullet. The bullet is of lead, pointed, it is secured to the case by indenting the latter in three places into the lower of three cannelures.

These cartridges are packed 96 in a "Box, ammunition, S.A., G.S." in bundles of 12. Weight of box, filled, about 97½ lb.

Cartridges, aiming-tube.

Mark I, case is of solid drawn brass with a cap chamber and anvil in the base; two fire holes in the anvil allow the flash to pass from the cap to the charge, which is 3¼ grains "Curtise and Harvey's Diamond No. 2" powder, over it are wads and a bullet of pure lead.

Mark II differs in the arrangement of the wads.

Packed 100 in a cardboard box and issued, usually, 10,000 in a tin lined box.

PROJECTILES.

| Nature. | | Mark. | Bursting Charge. | | Total Weight. | | |
|---------------|----------|-----------------------|------------------|----------------|---------------|------|-----|
| | | | Weight. | Powder. | | | |
| Shell | common | studded, cast-iron | II | lbs. oz. 17 12 | P. | 400 | |
| | | | III | 3 0 | F.G. | | |
| | | studless | cast-iron .. | II | 17 12 | P. | 400 |
| | | | | I | 3 0 | F.G. | |
| | | | cast steel | II | 17 0 | P. | 410 |
| | | | | III | 2 9 | F.G. | |
| | Shrapnel | studded, cast-iron .. | II | 40 0 | P. | 410 | |
| | | | III | 8 0 | F.G. | | |
| | | cast-iron .. | II | 40 0 | P. | 410 | |
| | | | I | 6 0 | F.G. | | |
| | | steel | II | 45 12 | Lyddite. | 410 | |
| | | | III | 1 9 | F.G. | | |
| Shot.. | Palliser | studded | II and III | 1 10 | " | 410 | |
| | | | I | 2 0 | " | | |
| | case .. | studless | II to VI | .. | .. | 410 | |
| | | | II to III | .. | .. | | |
| | | iron | III | .. | .. | 143 | |
| | | | IV | .. | .. | | |
| special | III | .. | .. | 410 | | | |
| | III | .. | .. | | | | |

The bursting charges given above are P. and F.G. mixture for common shell, except Lyddite for the guns on high angle mountings, and fine grain powder for Shrapnel.

All the above may be fired with full charges, except the studded Shrapnel, which are not strong enough to stand the full charge.

All the studded common and Palliser projectiles are fitted for Mark II attached gas-checks. The studded Shrapnel are not fitted for gas-checks.

All the studless projectiles, except case shot, are fired with automatic gas-checks.

Iron case shot are usually fired two at a time, as a single one does not give sufficient recoil.

Special case shot are intended for the defence of narrow channels.

Paper shot are for use at Station Practice where there is not a clear range. The cylinder breaks up on firing, and the small shot with which it is filled only travel a short distance (about 200 yards) whilst the effect for purposes of testing recoil, &c., is practically the same as that with a service projectile.

Palliser projectiles were formerly divided into shot and shell; the latter have been abolished, as such, and are now weighted up with sand to bring them up to the same weight as the shot. They are designated "Palliser shot," with the same numeral as the corresponding mark of shot.

Shells having the high explosive burster of Lyddite are painted yellow, all other projectiles black, except the studs. For distinguishing marks, see p. 39.

Common.

(Plates XV to XVIII.)

Studded.—Mark III is of cast-iron, about 3 calibres long; the head is struck with a radius of $1\frac{1}{2}$ calibres. The point is fitted with a gun-metal bush, tapped to G.S. fuze-hole gauge. Two rings of studs, of an

alloy of 10 parts of copper to 1 of tin, are pressed into undercut holes cut into the body of the shell. There are two extractor holes in the head. This shell is cast with a hole in the base to take the gas-check plug, which is fitted with a Mark II gas check.

Mark II was cast with a solid base, but afterwards had a hole bored in the base for the Mark II gas check plug, and, when so altered, is designated Mark II*.

Mark I is obsolete.

Studless.—Mark I is of cast-iron and differs from the above in being cast with bands; the head struck with a radius of two diameters; not having any studs; in having the base cast with a locking rim for the attachment of the automatic gas check; and a base plug with a flat head to allow the gas check to fit flat to the base of the shell.

Mark II is of cast-steel, consequently allowing the walls to be thinner and longer, and a larger bursting charge to be used. The base is closed by a metal adapter, screwed into the shell; the adapter is bored and tapped for the "small" base plug. The joint or recess between the metal of the shell and adapter is filled by a cold "small" lead ring, hammered in.

Mark III differs from Mark II in having thicker walls and base.

Lyddite studless.—Mark I is of forged steel, with bands. It has a solid base. A gun-metal socket is fitted in the nose and tapped to G.S. gauge. The inside is varnished instead of being lacquered.

Shrapnel.

(Plates XLV to XLV.)

Studded.—Mark III is of cast-iron. The length is about 3 calibres; the head has a radius of 1 calibre, and the body is fitted with two rings of studs; six longitudinal grooves are cast along the interior to ensure uniformity in breaking up. The base of the interior is contracted to form a chamber for the bursting charge, which is contained in a tin cup, to prevent loss and to guard against possible prematures from the roughness of the shell. Over the cup is fitted an iron diaphragm, having a hole in the centre for a piece of gas pipe which is screwed into it and extends to the fuze socket. The head of the shell is a thin cap of Bessemer metal fitting over a block of wood, which is bored out in the centre to take the fuze socket; it is secured to the walls by rivets and twisting pins, soldered over. The upper part of this socket is tapped inside to the G.S. gauge, and in the lower part to receive the primer. The shell is lined with brown paper and filled with 306 4-oz. or 376 3½-oz. sand shot.

Mark II differs from Mark III in not having the head countersunk at the top, and the head is struck with a radius of 1½ calibres.

Mark I is obsolete.

Studless.—The Mark I is similar to the Mark III studded shell, but the base is formed to take the automatic gas check, and the interior to hold 210 4-oz. sand shot; the head radius is 2 calibres.

The Mark II differs from Mark I in being of cast steel, an increased bursting charge is used, and 390 4-oz. sand shot carried.

Palliser.

(Plates XXII to XXIV.)

Studded.—These are pointed, for penetration purposes. They are cast downwards; the heads in a chill, a method ensuring hardness; while the bodies are cast in sand, and comparatively soft. They

are $2\frac{1}{2}$ calibres long, the heads being struck with a radius of $1\frac{1}{2}$ calibres. Mark VI is cast with bands and unturned body; the base is closed with a bush, bored and tapped for the gas-check plug, the recess round the bush is filled by having a cold lead ring hammered in.

Mark V had a stronger bush in the base than IV, and was altered for gas-check.

Mark IV was cast with a large cavity so that it could be used as a shell (having a bursting charge of 4 lb.); the base was closed by a metal plug.

Mark III was slightly shorter than II.

Mark II, first pattern having the body cast in sand and head in a chill.

Mark I was chilled all over; it is obsolete.

Those formerly termed "shell," all had a bursting charge, but the cavity is now filled with sand in order to bring them up to weight; they have a W painted white on the head, and stamped on the base plug.

Mark IV resembles, and corresponds with Mark VI shot.

Mark III with Mark IV shot.

Mark II with Mark II shot.

Mark I as for Mark I shot.

Studdess.—These are of cast-iron, from 2.4 to 2.7 calibres long; the bodies are turned or ground down, but bands are left on the head and base; the heads are struck with a radius of 2 diameters; the bases are curved and cast with grooves or serrations, and with a rim on the projection of the base form attachment for the automatic gas-check.

Mark III has a small core, closed by a soft cast-iron plug, firmly secured by being run in with molten lead.

Mark II, being formerly "shell," has a larger central cavity, and otherwise differs from III in having a 1-in. wrought-iron disc attached to the base by a coned metal base plug, with key-hole, screwed into a bush cast in the shell (no lead ring being necessary as with studded shot) instead of the projecting part on the base end forming part of the cast-iron shell, which was liable to injury in transit.

Mark I differs from II in having the projection on the base cast part of the shot.

Case.

(*Plates XXV and XXVI.*)

The Mark III case shot is of tinned iron in one piece, rivetted longitudinally and fringed at both ends. The bottom fringe is bent over a sheet iron bottom, and when the case is filled the upper fringe is bent over and soldered to the top. Two handles are attached to the top by staples, which are rivetted to the inside of the head. In the interior is placed a wrought-iron disc lying loosely on the bottom, and on this stand three wrought-iron segments forming a lining to the case. The case holds 139 8-oz. shot packed in clay and sand.

Mark II differs from Mark III in the weaker method of attachment of the handles. Mark I had the balls packed in coal dust.

The Mark IV or special case shot is similar in construction to Mark III, but it is three times the length, has six segments, lifting rings instead of handles, and is filled with 50 3-lb. $9\frac{1}{2}$ -oz. chilled iron shot packed in clay and sand.

Paper Shot.

Guns mounted in positions where regimental practice cannot be carried out in consequence of danger to shipping or other property, will be fired three times consecutively every second year, with paper shot and full charges. The shot will only be fired from guns having a clear range of 400 yards; they are made up in $\frac{1}{2}$ -charges.

Mark II is a cylinder of "papier-mâché," with a hard black polished surface closed at each end by a disc of the same material; the top disc has a hole in it through which it is filled, and which is afterwards closed by a cork plug. Mark III is similar to Mark II, but the discs are stouter, and it is made of wood pulp. A few Mark I were supplied; they consist of brown paper, pasted and rolled, and choked to a wood top and bottom, and filled through a hole in the top, closed by a wood plug. The cylinders are issued empty, and when required for use they are filled with a sufficient quantity of shot (Nos. 1 to 5) and sawdust. When firing paper shot the gun must be run up carefully to prevent forward movement by the carriage striking the buffer stops too violently.

GAS CHECKS.

These are discs of copper of the same diameter as the projectiles.

The Mark II rotating gas-check is used with common and Palliser studded projectiles, and is attached by means of a plug and nut (see Plate XV). It has seven projections round the edge, which fit into the grooves of the gun. A shoulder on the plug prevents the nut from being screwed home against the gas-check; consequently, the latter has a small amount of play and is free to rotate round the plug, which is necessary in a gun with an increasing twist of rifling in order to prevent the gas-check from jamming. Studded Shrapnel are not fitted for gas-checks.

Mark I is obsolete.

The automatic gas-check completely covers the base of the projectile, and is issued with all projectiles, including Shrapnel, except case shot. It not only seals the escape of gas, but also imparts rotation to the projectile (Plate XVI). There are two patterns of the "Gas-check, R.M.L., 10-inch, automatic," with seven projections for Marks I and II guns.

Mark II is well shaped so that it will fit over the projection on the base of the projectile. There are projections on the circumference corresponding with the grooves on the gun. It is hollowed out behind the projections so as to readily expand into the rifling. Mark I is similar, but it is not hollowed out behind the projections.

The "Gas-check, R.M.L., 10-inch, polygroove, Mark I," is of the ordinary automatic shape and fitted on the edge with 32 projections, hollowed out.

INSTRUCTIONS FOR THE PREPARATION OF PROJECTILES.

Extracts from "Regulations for Magazines and the Preservation of Artillery Matériel."

Fixing Gas-checks to Studded Projectiles . . .

"338. Unscrew the nut and remove it, then apply the 'Wrench, base plug,' to the gas-check plug, and screw it well up in the

direction of the arrow* to ensure its being well home. If, when unscrewing the nut, the plug also unscrews, the latter should be held with the wrench. Place the gas-check on the base of the projectile, with the concave, or unpainted side, next the base, then screw the nut on to the end of the plug with the 'Spanner gas-check nut.'

Fixing Gas-checks to Studless Projectiles . . .

"341. Except for high angle . . . guns these gas-checks are placed in the bore of the gun loose, and become fixed to the projectile when the gun is fired. For 9 and 10-inch high angle guns the gas-checks are attached to the shells before loading with an 'Instrument, fixing gas-check.' . . .

"342. For drill purposes, in order to facilitate unloading, the gas check should be attached to the base of the shell by indenting it with a blunt tool at two or three points in that part which surrounds the neck of the projecting base of the projectile.

Fixing Plugs and Fuzes.

"345. When plugs or metal fuzes are screwed into shells, they will, unless required for immediate use, be lubricated with a mixture composed of 100 parts (by weight) of Mark III luting, and mineral jelly in equal proportion by weight. Each is issued in 1 lb. tins and will be mixed locally. The mixture is to be applied to the threads of the fuze or plug with a brush, in sufficient quantity to cover them, care being taken that it does not extend over the bottom. A coat of paint of the same colour as the tip of the shell will be applied over the junction of the G.S. fuze-hole plug and shell, when the latter is filled.

"346. Projectiles fitted with plugs and kept in exposed situations where the plugs are liable to become set fast by corrosion from the action of salt water, or otherwise, should have the plugs that are not covered by wads or lead discs occasionally unscrewed and re-lubricated as above, a coat of paint being applied as in para. 345, care being taken that this is only done when the hygrometric conditions are favourable. No plugs will be removed whilst moisture is condensing on the outside of the shell. Plugs covered with Naval wads or lead discs will not be removed, unless their wads or discs are loose or defective.

"347. Instances have occurred in which fuze-hole plugs of common shells have been so jammed in as to be immovable, in consequence of using the 'wrench, base plug.' The 'key, fuze and plug, G.S.,' 'key, fuze, universal,' and 'key, plug, G.S.,' are the only implements which should be used for screwing in the G.S. plug.

NOTE.—In cases where plugs are found to be tightly jammed in shells, the 'key, fuze and plug, G.S.,' must be used for starting the plug; any attempt to remove such plugs solely by means of the 'key, fuze, universal' may result in its being damaged.

"348. Any plugs or metal fuzes of filled shells, or adapters of empty shells, that may be sentenced by the Inspecting Ordnance Officer, at his Annual Inspection, to be re-lubricated will be removed and lubricated as laid down in para. 345, and then screwed tightly home. The plugs and recesses will then be well painted with the same colour as the tip of the shell. Shells which are stored on their bases.

* The heads of the gas-check plugs, and the nuts, are each stamped with an arrow to show the direction in which to turn either when screwing in the plug or screwing on the nut.

will not be removed for this operation. The work of lubricating and painting will be carried out under an Officer or Master-Gunner of the Sub-District in which the shells are on charge. (For quantity of paint, time, and working pay for this service, see Equipment Regulations.)"

DISTINGUISHING MARKS.

Extracts from "Regulations for Magazines and the Preservation of Artillery Matériel."

"366. Projectiles will be painted and marked as follows :—

(1) *Tips* :—

Shot (except case).—To have white tips.

Common and Palliser shell, except lyddite shells.—To have black tips.

Shrapnel shell.—To have red tips.

Lyddite shells.—When filled and fuze, the kit plaster covering the tip to be painted red.

(2) *Bands* :—

Steel projectiles.—To have white band round head, except lyddite shells.

Armour-piercing shell.—To have two white bands round head.

All filled shells.—To have red band round head.

Case shot containing chilled iron balls.—To have white band round body.

Projectiles manufactured, or sentenced, for practice only (being unfit for service purposes).—To have yellow band round body.

(3) *Bodies* :—

Lyddite shells to be yellow; . . . all other projectiles to be black.

The letters C.S. are stamped on the base of the cast-steel and F.S. on the base of forged-steel shells.

"367. The following additional markings in red paint will be shown on all shells, . . .

(a) The word 'fuze' if the shell is fuze.

(b) The word 'bag,' if one has been used.

(c) The monogram of the station . . .

(d) The date of filling.

(e) A 1-inch disc, if shalloon primers have been inserted.

(f) The letters P. or Q.F. ($1\frac{1}{2}$ -inches long for 7-inch and upwards, and 1 inch long for smaller natures), if filled with P. and F.G. or Q.F. and F.G.

(g) The words 'with exploder,' on lyddite shells if an exploder is used.

(h) If the shell is fuze with a base fuze, the head of the fuze or the lead cap covering it to be painted red.

"368. The sizes of the type, except as in (f), will be :—

Over 4-inch $\frac{3}{4}$ inch.

The tips will be 1 inch deep in projectiles fitted for nose fuzes, but the same stencil being used for sharp-nosed projectiles, the tips on the latter will be correspondingly wider. The bands will be $\frac{1}{2}$ inch wide,

the white band, denoting steel, being immediately below the tip, and the red one, denoting filled, $\frac{1}{2}$ an inch lower, except on armour-piercing shot, where the white band is 1 inch below the white tip. On armour-piercing shell the second white band is $\frac{1}{2}$ an inch below the first.

× “369. Palliser shot (formerly termed shell), when weighted with sand, and armour-piercing shot when weighted with sawdust and small shot will be marked with the letter W stencilled in white on the head and stamped on the base plug.

“370. Shells which have been emptied will be marked on the head with the letter E in red paint, and also the monogram of the station

“371. Projectiles sentenced for practice only, will be marked with a yellow band round the body $\frac{1}{2}$ inch wide to distinguish them from service projectiles, all the lettering indicated in para. 367 (a) to (f) being obliterated, but the tip and bands, including the red band, if filled, being left.

“373. Stencil plates for the letters and figures will be made locally. Stencil plates or an instrument for painting the tips and bands will be supplied from Woolwich.”

WEDGE WADS.

These consist of two wood wedges 7-in. long, connected by a piece of cane 7·5-in. long. They are rammed home after the projectile to prevent it slipping forward when the gun is run up. An extractor is not to be used to unload a gun whilst a wedge wad remains rammed home. If the wad cannot be removed by means of a wad hook, the charge must be fired.

FUZES.

| | | |
|------------|---|---|
| Percussion | { | Pettman G.S., No. 5, Mark II. Direct action, No. 3, Marks I* and II for land fronts, Mark III for sea fronts. Direct action impact, No. 13, Mark II. |
| Time | { | 15 seconds, with detonator, No. 43, Mark III. Sensitive, middle No. 24, Mark I. Percussion, middle No. 54, Mark II. |

The Pettman fuze is for use with full charge only.

15 seconds M.L. No. 41 may be used in shells not fitted for gas-checks, *i.e.*, studded Shrapnel.

Pettman G.S. Fuze, No. 5.

(Plate XXVII.)

The fuze consists of the following parts:—

Body (A) is threaded on the outside to the G.S. gauge, top plug (B), plain ball (C), steady plug (D), detonating ball (E), cone plug (F), lead cup (G), and suspending wire (H).

The body and top plug are made of gun-metal; the cone plug, detonating ball, and steady plug are also of gun-metal, but of a harder alloy to prevent them from altering their shape; the plain ball is of brass, and the suspending wire of copper.

The plain ball is held in position by a cup in the steady plug; round the latter there is a ring of composition covered by a thin, lacquered copper washer. Through the steady plug are two fireholes to convey the flash from the ring of composition to the interior of the fuze. The detonating ball is milled, grooved, and covered with detonating composition, protected by one thickness of gut and two of silk, over which are two copper hemispheres, covered again by one thickness of gut and three of silk; it is held in position by a cap in the steady plug. The cone plug is pierced with three fireholes, of which the central one is driven with meal powder and pierced like a tube. The lead cup is a hollow cylinder, having a flange on the top to fit into a recess on the cone plug when it is crushed. The suspending wire passes through the cone plug.

When fired, the steady plug, ball, and cone plug set back on the shock of firing, the suspending wire is broken, the lead cup prevents rebound, and the stem of the cone plug protrudes through the base of the fuze, the detonating ball being released by the slight unsteadiness of the shell in flight; on striking, the ball is dashed violently against the side of the body, explodes the detonating composition, and fires the shell, the flash passing through the holes in the cone plug to the priming, and thence to the bursting charge.

When fired with a projectile fitted with a gas-check, the steady plug may not disengage, owing to the steadiness of flight of these shells, and in this case the detonating ball will not act. The plain ball is released by the steady plug setting back, and is caused by the centrifugal force to spin round the circumference of the body over the ring of detonating composition. On striking, the ring is dashed against the plain ball, and detonates, exploding the shell through the fireholes.

The fuze acts on impact only.

Direct Action, No. 3.

(Plate XXVIII.)

The Mark III fuze consists of the following parts, viz., body, cap, screw plug for needle disc, needle disc, screw collar, bottom screw plug, steel needle.

It is made of an alloy resembling gun-metal, with the exception of the steel needle, copper disc, and a few minor portions.

The *body* is threaded throughout on the exterior to the general-service taper and pitch, and can be screwed into the shell to admit the naval wad being placed over it. The lower part is hollowed out to receive a blowing charge of 75 grains pistol or R.F.G.². The upper portion of the body is bored out to receive the safety plug, screw plug for needle disc, and screw collar. There is a recess below these to receive the detonating composition, consisting of three grains of cap composition, varnished, and covered with a disc of varnished paper, having on the top a copper washer kept in position by being spun over. At the bottom of this recess there are nine conical fire-holes to allow the flash of the detonating composition to pass to the powder. These holes are filled with meal powder paste, and covered on the under side by a disc of fine white paper and on the upper side by a tin foil disc, to prevent the detonating composition working through to the power. The top is closed by the safety plug.

The *screw plug for needle disc* is tapped so as to screw into the body, and is recessed. It is slightly coned at the bottom, and has a hole through the centre. Two holes are drilled in the top so as to screw the plug into the fuze. The needle disc is of copper, with the steel needle in the centre; it rests on the screw plug for needle disc.

The *screw collar* screws into the body over the screw plug, having two slots cut in its upper edges for that purpose.

The *needle disc* is of copper, .032-in. thick, and has a central hole to receive the needle.

The *needle* is of steel, and of the shape shown in the section, having four points. It is sprung into the disc.

The *bottom plug* has a central hole and two key holes for screwing it in. It is secured and rendered damp-proof by cement and solder.

Action.—It is prepared by simply removing the safety plug, with the flat end of the fuze key, universal; an arrow on the plug shows the way it is to be turned. The fuze is at rest in all its parts till direct impact takes place, or a graze at such an angle that the nose of the shell enters the ground. When either of these events occurs the needle is crushed down on to the detonating composition, which fires, and ignites the meal powder in the conical holes and the fine grain powder. The flash therefrom blows down into the shell and fires the charge.

The head of the needle being some distance below the head of the fuze, it cannot be touched or forced down on the detonating composition when any ordinary rammer is used for loading.

Mark II, generally, is similar to Mark III, except that externally the upper portion is turned to receive a cap, having on each side a T-shaped slot to fit over brass pins on the body of the fuze, and a square fuze-key hole in the top for fixing the fuze in the shell. Internally, there is no safety plug in the head nor tin foil disc under the detonator.

Mark I* is almost identical, being the Mark I fuze converted to Mark II pattern. Mark I, as such, is obsolete.

Direct Action, No. 13.

Mark II fuze is for projectiles charged with lyddite. The body is of gunmetal, 2.2-in. long, and screwed to the G.S. fuze gauge. It is fitted with a steel cap, and is externally similar to that for the No. 3, and is put on or removed in the same way; it is blacked to prevent rust.

Mark I is not used for this gun.

15 Secs. Time with Detonator, No. 43.

(Plate XXX.)

Mark III is of beech wood, coned to suit the G.S. fuze-hole gauge. It has a central composition channel, six powder channels, and a detonator screwed into the head.

The detonator consists of a body of gun metal; hammer supported by a copper wire; and a recess containing detonating composition.

The central channel is driven with fuze composition, having a .75 inch pellet of meal powder above the composition to prevent cracking when boring for short ranges, which would be the case with composition; the channel is lined with paper, to prevent space between the wood and fuze composition in the event of the wood shrinking.

The six powder channels are bored parallel to the central channel and connected at the bottom by quick match, placed in an annular groove, and closed by pellets of powder; side holes are bored into the channels and covered with paper, upon which the numbers are painted (reversed to facilitate preparation), and a yellow dot is placed over each side hole.

The steel safety pin passes through the head of the fuze and hammer, so that the fuze cannot be fired accidentally.

Three escape holes above the composition channel allow the gas from the composition to pass out; these are threaded with quickmatch, and protected by copper discs and papier-maché wads, which are forced out by the gas.

The head is woolded with copper wire, soldered over, to prevent splitting. The top is covered by a paper disc showing directions.

The fuze is prepared by being bored through the side hole and powder channel into the composition channel; the safety pin is removed by the braid attached to it; this is done before ramming home in M.L. guns.

Action.—On discharge the hammer sets back and shears the copper suspending wire, ignites the detonating composition, and in turn the power pellet and fuze composition, till the bored side hole is reached, when the shell is exploded.

Mark II differs principally in having a thicker suspending wire, consequently it is not so sensitive on discharge of the gun. The safety pin passes under the detonating hammer, and the copper woolding is lower on the fuze.

Mark I is obsolete.

Sensitive, Middle, No. 24.

(Plate XXX.)

Mark I fuze consists of the following parts:—

Body, with stem, threaded on lower part of the outside to G.S. gauge and containing a blowing charge of M.G.¹ powder; an axial magazine with R.F.G.² powder; composition ring, with fuze composition having leather and paper washers under it; steel needle; lighting pellets, with spiral springs; dome and nut; two copper safety pins; and bottom plug.

All the metal parts are of gunmetal.

A leather washer is fitted under the shoulder of the fuze, closing the joint between the plug and shell.

The composition ring is graduated on its periphery from 0 to 30, and reads to half-seconds, subdivided into eighths. An ψ is stamped on the ring to show the safety point, and when this coincides with the Λ on the body the fuze is set at safety. The cap which screws on to the top of the pillar is made hexagonal, to fit the "Key, fuze, universal."

The fuze is set, after being fixed in the shell, by loosening the screw cap on the top of the stem, by means of the "Key, fuze, universal," and turning the dome and ring till the required graduation on the collar coincides with the arrow head on the body, and then tightening the screw cap. The safety pins are withdrawn at the moment of loading. On discharge the centrifugal action causes the remaining pellets to fly out, releasing the lighting pellet, which flies out by centrifugal force against the needle, firing the detonator, which ignites the powder in the pellet and axial magazine, this latter lighting the quickmatch in the composition ring.

Weight 1 lb. 4 oz.
 Time of burning at rest, 14.8 to 15.4 secs.
 When the stock is used up, this fuze will be replaced by "Time and Percussion, Middle, No. 54."

Time and Percussion, Middle, No. 54.

(Plate XXXI.)

The body, Mark III, is hollow, with a stem on the upper side. Round the base of the stem an annular groove is cut, from which a hole is bored to the side of the body for the gas to escape. The sides of the body are pierced with three fire holes; the top of the body is screwed to receive a hexagonal cap. The cap fits the hexagonal hole in the centre of the "Key, fuze, universal." Between the cap and the dome fits a brass washer with feathers fitting into slots on the stem of the body; it is to prevent the dome from turning with the nut and altering the setting of the fuze when the cap is screwed tight.

The composition ring has an annular groove round it for the composition; a projection on the upper side contains the hammer with steel needle, suspended by a .022-in. wire, and a detonator under it for lighting the composition in the ring. The hammer is also secured by a safety pin passing under it, the hole in the ring left by its withdrawal being closed by a brass pellet with a spiral spring above it.

The composition ring is barrel-shaped outside to facilitate the setting of the fuze. The ring is kept in position by three projections on the side, which fit closely round the stem of the body. Two escape holes are at the top of the ring at the commencement of the composition, and three radial ones are bored through the inner side at equal distances round it.

The top and first radial holes are covered with paper, the two other radial holes with asbestos. The ring is graduated from 0 to 30, and reads to quarter units; each division has four subdivisions. There is an arrow-head between the last graduation and the commencement to show the position of safety.

To set the time arrangement of the fuze, the nut is loosened with the "Key, fuze, universal," and the ring moved round till the required graduation is opposite the arrow on the body; the nut is then tightened, great care being taken to see that it is screwed down as tightly as possible.

The time of burning of the fuze at rest, when set at 30 or full length, is 16 seconds.

The action of the time arrangement is that, on discharge, the hammer sets back, shearing the suspending wire, and fires the detonator, which lights the end of the ring of composition; this burns until the channel communicating with the lower part of the fuze is reached, when the flash passes down it and fires the detonator and magazine in the percussion arrangement.

Mark II differs from Mark III, by the latter having a percussion arrangement similar to that in the "Time and percussion fuze, No. 56, Mark IV"; the time ring having no escape holes, except the two at the commencement of the fuze composition, the loops of the eyes of the safety pins are stronger.

Mark I has been altered to agree with Mark II.

Weight 1 lb. 4 oz.

TUBES.

- Tube, friction, copper, solid-drawn, with ball, Mark II.
 „ electric, No. 10, Mark III and IV.
 „ vent-sealing, electric, P., Mark III to VII.
 „ drill, Mark III.*
 Primer, vent, cordite, Mark I.

The guns are fired by friction tubes, except when they are in connection with a position-finder, when No. 10 electric tubes are used. The vent-sealing electric P. tubes are for guns on high-angle mountings, which are fitted with a special steel vent for vent-sealing tubes, and having no percussion lock, cannot be fired except by electricity.

The tube, *friction, copper, solid-drawn, with ball, Mark II* (Plate XXVII) is of solid-drawn copper, and has a solid head; it is filled with pistol powder, and the bottom is closed by a brass ball over which is a cork plug, secured by shellac. The length is 2.1-in.

A hole is bored in the tube, near the top, for the insertion of the nib-piece which projects right through. The nib-piece is solid-drawn, and has a hole bored in it to allow the flash from the composition to reach the powder in the tube. The nib-piece is filled with a detonating composition of chlorate of potash, sulphur, and sulphide of antimony; into this is thrust the roughened end of a friction bar, the other end of which has a vertical eye to take the hook of the lanyard. On pulling the lanyard the friction bar is drawn out, igniting the composition, and firing the tube; the central hole gives a passage for the flash and causes instantaneous action. The gas from the exploded cartridge drives the tube out of the vent.

Mark I (without ball) is not used with this gun.

Packed 25 in a tin cylinder.

Tube, electric, No. 10, Mark III.—This tube is made up from three quills cemented together. The two lower ones are filled with mealed powder, as in copper tubes; the upper quill contains an ebonite plug about 1-in. long, in which two longitudinal grooves are cut to take the bare ends of the terminals of the leads. The ends of the wires are joined by the naval bridge, which is surrounded by the priming composition of gun-cotton dust and mealed powder, packed closely into the cavity between the ebonite plug and the mealed powder in the lower tube. On the top of the powder in the lower tube is a small wad of gun-cotton to prevent the priming falling away into the central hole of the tube and leaving the bridge bare.

To prevent the tube being inserted too far into the vent a frapping of thread is made on the wires about 1-in. from the top quill.

The upper end of each wire terminates in a spiral .6-in. long for joining to the leads from the battery. The spirals are coated with tin and covered with oiled silk, secured by shellac varnish. The tube is varnished with shellac.

Mark IV differs from the above in having its wires and poles coated with tin, and in having its bridge attached with that metal instead of solder.

They are packed 25 in a tin cylinder.

Vent-sealing tubes without ball were re-introduced for use with cordite charges, but may be used with powder charges, a cordite primer being inserted in the vent.

* When worn out service tubes will be used instead.

The *tube, vent-sealing, electric, P.*, is of brass, bored out to receive the arrangement for firing by electricity, and coned at the top of the tube to receive two conical plugs, which are insulated from the body and from each other by ebonite. Into each plug is fastened a copper pole. The poles are connected by a platinum wire bridge surrounded with priming composition. The lower part of the tube contains pistol powder, and is closed at the bottom by a thin disc of paper and by a cork plug coated with varnish.

The top of the tube is flat. The terminals come out at the centre of the top, then separate, and are led in opposite directions to the edge. They follow the edge in a groove till they again meet, when they are twisted together for a length of 22-in. They are insulated by being covered with layers of varnished sarcenet, oiled silk was formerly used for this purpose.

Mark VII is the same as Mark VI; but the terminals are brought out through a hole in the side, and are covered for 5-in. with oiled silk.

Mark V, Plate XXXII, was exactly similar, but was closed at the bottom by a thick disc of paper and brass ball secured with sulphur.

Mark IV differs from Mark V only in the internal arrangements for sealing the gas escape.

Mark III differed from Mark IV in being closed at the bottom by a cork instead of a brass ball, and in the leads being 21-in. long.

They are packed 5 in a tin box.

Tube, vent-sealing, electric, P., drill (Plate XXXIII).—The body of Mark I tube is made of gun-metal in three parts, screwed together and milled outside, as shown in the plate. There are two escape holes through the head, and two holes lined with ebonite cylinders, through which the wire terminals pass and project into the interior to form the poles. These are connected by a platinum silver bridge soldered to them.

Mark II differs from Mark I in having a brass plate fitting into an undercut slot in the head, and in minor interior details.

Mark III differs from Mark II in having the leads 22-in. long instead of 18-in. Earlier issues of Mark III have leads 21-in. long.

These tubes are issued empty. When required for use they will be charged by the Inspecting Ordnance Officer.

Primer, vent, cordite.—It consists of a stick of cordite, size 20, 4½-in. long, for use with vent-sealing tubes without ball, with powder charges only.

ELECTRICAL APPARATUS.

BATTERY AND KEY, TEST AND FIRING.

This key and battery is designed to serve two purposes—

1. To test the tube and circuit when the gun is made ready to fire.
2. To fire the tube.

To enable this to be done an indicator is fitted within the firing key itself, which is so arranged that when the knob is turned to the right the current passes through the indicator and the rest of the gun circuit, and if this is complete a visible and audible signal is given. If it is then required to fire, the knob is pressed in, which action cuts the indicator out and allows the full current to flow through the circuit, firing the tube.

An arrow is cut on the face of the knob as an indicator; when the arrow is vertical the circuit is broken and the gun cannot be fired.

Besides this, the apparatus may be used in place of the Menotti cell and galvanometer for testing tubes and firing wires.

The Leclanché cells, of which there are two in the battery box, are issued with the sal ammoniac in them, and all that is required to make them ready for use is to fill the cells two-thirds full with water, and to see that this is added from time to time to make up for evaporation.

When the battery fails to fire a tube, fresh sal ammoniac (about 4 oz. to each cell) should be added, the old solution being thrown away.

The apparatus is suitable for firing any low tension fuze or tube through a short length of wire, about 50 yards of No. 16 copper wire (.065 inch diameter).

Precautions to be observed.

Before any wires are attached to the key, care should be taken that the arrow on the knob points upwards, and the key should be tried to see that it works freely and correctly.

The firing wires must not both be connected up to the firing key until after the gun is laid and ready to fire, and the front is clear. The turning of the knob should be done just before it is required to fire, and it may either be held turned or not, as desired, until the gun is fired by pressing it in.

The following rules will detect the particular cause of failures to fire with electric tubes—

1. If the indicator works properly, and yet when the knob is pressed in the tube does not fire, the fault is a short circuit between the firing leads or in the tube itself.
2. If the indicator works feebly only, some bad joint in the circuit will be the probable cause.
3. If it does not move at all, the circuit is broken at some point in the wires or in the tube itself.
4. If the indicator works when the knob is turned and the gun does not fire when it is pressed, and then when the knob is turned again the indicator does not work, this shows that the tube was fired without igniting the charge.

To eliminate faulty tubes, it is as well to test them before use out of the gun. This should be done under precaution, so that in case of a tube being accidentally fired, no damage would ensue. The firing leads may also be tested, and the apparatus may be considered to be in good order if on joining the terminals with a short piece of wire, and turning the knob, the indicator works well. If it should only work feebly, the battery should be examined, as in this case it will not give sufficient current to fire with certainty.

RANGE TABLE FOR 10-IN. R.M.L. GUN.

Charge { weight, 70 lb.
gravimetric density $\frac{29.6}{0.987}$
nature, P.

Projectile { nature, common shell, Mark II or Palliser shot, with gas-check,
weight, 410 lb.

Muzzle velocity, 1379 f.s.

Nature of Mounting, wrought-iron garrison.

Jump, 5 minutes.

| Remaining velocity. | | To strike an object 10-ft. high, range must be known within | Slope of descent. | 5 minutes' elevation or deflection alters point of impact. | | | Range. | Fuze scale for 15 secs. wood M.L. | 50 per cent. of rounds should fall in | | | Time of flight. | Penetration into wrought-iron. |
|---------------------|--------|---|-------------------|--|--------|--------------------------|--------|-----------------------------------|---------------------------------------|--------|---------|-----------------|--------------------------------|
| f.s. | yards. | | | 1 in | yards. | Laterally or vertically. | | | Elevation. | yards. | Length. | | |
| | | | | yards. | yards. | ° | | | yards. | yards. | yards. | secs. | inches. |
| 1365 | 635 | 381 | 56.7 | 0.14 | 0.3 | | 100 | 0.0 | 6 | 0.93 | 0.01 | 0.22 | 13.0 |
| 1351 | 517 | 190 | 55.7 | 0.23 | 0.12 | | 200 | 1.0 | 6 | 0.93 | 0.02 | 0.44 | 12.9 |
| 1337 | 212 | 127 | 54.7 | 0.43 | 0.21 | | 300 | 1.5 | 6 | 0.93 | 0.03 | 0.66 | 12.7 |
| 1323 | 155 | 93 | 53.8 | 0.58 | 0.30 | | 400 | 2.0 | 6 | 0.93 | 0.05 | 0.89 | 12.6 |
| 1310 | 122 | 73 | 52.9 | 0.72 | 0.33 | | 500 | 2.5 | 6 | 0.93 | 0.07 | 1.12 | 12.4 |
| 1297 | 100 | 60 | 52.0 | 0.87 | 0.48 | | 600 | 3.0 | 6 | 0.94 | 0.09 | 1.35 | 12.3 |
| 1284 | 83 | 50 | 51.1 | 1.01 | 0.58 | | 700 | 3.5 | 6 | 0.94 | 0.11 | 1.58 | 12.1 |
| 1271 | 72 | 43 | 50.3 | 1.16 | 1.8 | | 800 | 4.5 | 6 | 0.94 | 0.13 | 1.82 | 12.0 |
| 1258 | 63 | 38 | 49.5 | 1.31 | 1.18 | | 900 | 5.0 | 6 | 0.94 | 0.15 | 2.06 | 11.8 |
| 1244 | 57 | 34 | 48.7 | 1.45 | 1.28 | | 1000 | 5.5 | 6 | 0.94 | 0.17 | 2.30 | 11.7 |
| 1231 | 50 | 30 | 47.9 | 1.60 | 1.33 | | 1100 | 6.0 | 6 | 0.95 | 0.19 | 2.54 | 11.6 |
| 1219 | 45 | 27 | 47.2 | 1.74 | 1.43 | | 1200 | 6.5 | 6 | 0.96 | 0.21 | 2.78 | 11.5 |
| 1207 | 42 | 25 | 46.5 | 1.89 | 1.53 | | 1300 | 7.5 | 6 | 0.97 | 0.23 | 3.03 | 11.3 |
| 1195 | 38 | 23 | 45.8 | 2.03 | 2.9 | | 1400 | 8.0 | 6 | 0.98 | 0.25 | 3.28 | 11.2 |
| 1186 | 35 | 21 | 45.1 | 2.18 | 2.20 | | 1500 | 8.5 | 6 | 0.99 | 0.28 | 3.53 | 11.1 |
| 1175 | 32 | 19 | 44.5 | 2.32 | 2.31 | | 1600 | 9.0 | 6 | 1.00 | 0.32 | 3.78 | 11.0 |
| 1164 | 30 | 18 | 43.9 | 2.47 | 2.42 | | 1700 | 9.5 | 6 | 1.01 | 0.37 | 4.04 | 10.8 |
| 1153 | 28 | 17 | 43.3 | 2.61 | 2.53 | | 1800 | 10.5 | 7 | 1.00 | 0.43 | 4.30 | 10.7 |
| 1142 | 27 | 16 | 42.7 | 2.76 | 3.4 | | 1900 | 11.0 | 7 | 0.98 | 0.47 | 4.56 | 10.6 |
| 1132 | 25 | 15 | 42.1 | 2.91 | 3.15 | | 2000 | 11.5 | 8 | 0.97 | 0.53 | 4.82 | 10.5 |
| 1122 | 23 | 14 | 41.6 | 3.05 | 3.27 | | 2100 | 12.0 | 8 | 0.95 | 0.60 | 5.09 | 10.4 |
| 1113 | 22 | 13 | 41.1 | 3.20 | 3.39 | | 2200 | 13.0 | 9 | 0.93 | 0.69 | 5.36 | 10.3 |
| 1104 | 20 | 12 | 40.6 | 3.34 | 3.51 | | 2300 | 13.5 | 10 | 0.92 | 0.80 | 5.63 | 10.2 |
| 1095 | 19 | 12 | 40.1 | 3.49 | 4.3 | | 2400 | 14.0 | 10 | 0.90 | 0.93 | 5.90 | 10.1 |
| 1087 | 18 | 11 | 39.6 | 3.63 | 4.15 | | 2500 | 15.0 | 11 | 0.89 | 1.08 | 6.18 | 10.0 |
| 1079 | 17 | 10 | 39.2 | 3.78 | 4.27 | | 2600 | 15.5 | 12 | 0.88 | 1.26 | 6.46 | 10.0 |
| 1070 | 17 | 10 | 38.8 | 3.92 | 4.40 | | 2700 | 16.5 | 13 | 0.87 | 1.44 | 6.74 | 9.9 |
| 1061 | 16 | 9.5 | 38.4 | 4.07 | 4.53 | | 2800 | 17.0 | 14 | 0.86 | 1.57 | 7.02 | 9.8 |
| 1053 | 15 | 9.1 | 38.0 | 4.21 | 5.6 | | 2900 | 18.0 | 14 | 0.85 | 1.64 | 7.30 | 9.7 |
| 1045 | 14 | 8.7 | 37.6 | 4.35 | 5.19 | | 3000 | 18.5 | 15 | 0.85 | 1.70 | 7.59 | 9.6 |
| 1038 | 14 | 8.4 | 37.2 | 4.51 | 5.32 | | 3100 | 19.0 | 15 | 0.84 | 1.75 | 7.83 | 9.6 |
| 1031 | 13 | 8.1 | 36.8 | 4.65 | 5.45 | | 3200 | 20.0 | 15 | 0.85 | 1.80 | 8.17 | 9.5 |
| 1024 | 13 | 7.7 | 36.5 | 4.80 | 5.59 | | 3300 | 20.5 | 14 | 0.86 | 1.85 | 8.46 | 9.4 |
| 1018 | 12 | 7.4 | 36.2 | 4.94 | 6.13 | | 3400 | 21.5 | 14 | 0.87 | 1.90 | 8.75 | 9.3 |
| 1013 | 12 | 7.1 | 35.8 | 5.09 | 6.27 | | 3500 | 22.0 | 14 | 0.88 | 1.95 | 9.04 | 9.3 |
| 1008 | 12 | 6.9 | 35.5 | 5.23 | 6.41 | | 3600 | 22.5 | 14 | 0.89 | 2.00 | 9.31 | 9.2 |
| 1003 | 11 | 6.6 | 35.2 | 5.38 | 6.55 | | 3700 | 23.5 | 14 | 0.90 | 2.01 | 9.64 | 9.2 |
| 998 | 11 | 6.4 | 34.9 | 5.52 | 7.9 | | 3800 | 24.0 | 13 | 0.91 | 2.08 | 9.94 | 9.1 |
| 993 | 10 | 6.2 | 34.6 | 5.67 | 7.24 | | 3900 | 25.0 | 13 | 0.92 | 2.12 | 10.24 | 9.1 |
| 988 | 10 | 6.0 | 34.3 | 5.81 | 7.39 | | 4000 | 25.5 | 13 | 0.93 | 2.16 | 10.54 | 9.0 |
| 982 | 10 | 5.8 | 34.0 | 5.96 | 7.54 | | 4100 | 26.5 | 13 | 0.94 | 2.22 | 10.84 | 9.0 |
| 976 | 9 | 5.6 | 33.7 | 6.11 | 8.9 | | 4200 | 27.0 | 13 | 0.95 | 2.29 | 11.14 | 8.9 |
| 970 | 9 | 5.4 | 33.4 | 6.25 | 8.24 | | 4300 | 28.0 | 13 | 0.96 | 2.37 | 11.45 | 8.9 |
| 965 | 9 | 5.2 | 33.1 | 6.40 | 8.40 | | 4400 | 28.5 | 13 | 0.97 | 2.45 | 11.76 | 8.8 |
| 960 | 8 | 5.0 | 32.9 | 6.54 | 8.56 | | 4500 | 29.5 | 12 | 0.98 | 2.51 | 12.07 | 8.8 |

RANGE TABLE FOR 10-IN. R.M.L. GUN—continued.

| Remaining velocity. | To strike an object 10-ft. high, range must be known within | Slope of descent. | 5 minutes' elevation or deflection alters point of impact. | | | Range. | Fuze scale for 15 secs. wood M. L. | 50 per cent. of rounds should fall in | | | Time of flight. | Penetration into wrought-iron. |
|---------------------|---|-------------------|--|--------------------------|------------|--------|------------------------------------|---------------------------------------|----------|---------|-----------------|--------------------------------|
| | | | Range. | Laterally or vertically. | Elevation. | | | Length. | Breadth. | Height. | | |
| f.s. | yards. | 1 in | yards. | yards. | ° ' " | yards. | 20.0 | yards. | yards. | yards. | secs. | inches. |
| 956 | 8 | 4.9 | 32.6 | 6.69 | 9 12 | 4600 | | 12 | 0.99 | 2.63 | 12.4 | 8.7 |
| 951 | 8 | 4.7 | 32.3 | 6.83 | 9 23 | 4700 | | 12 | 1.00 | 2.71 | 12.7 | 8.7 |
| 946 | 8 | 4.6 | 32.0 | 6.98 | 9 44 | 4800 | | 12 | 1.02 | 2.81 | 13.0 | 8.6 |
| 942 | 7 | 4.4 | 31.8 | 7.13 | 10 0 | 4900 | | 12 | 1.03 | 2.90 | 13.3 | 8.6 |
| 937 | 7 | 4.3 | 31.5 | 7.27 | 10 17 | 5000 | | 13 | 1.06 | 3.02 | 13.7 | 8.5 |
| | | | | | | | | | | | | |
| 933 | 7 | 4.1 | 31.2 | 7.42 | 10 34 | 5100 | | 13 | 1.07 | 3.16 | 14.0 | 8.5 |
| 929 | 7 | 4.0 | 30.9 | 7.58 | 10 51 | 5200 | | 13 | 1.09 | 3.31 | 14.3 | 8.4 |
| 924 | 6 | 3.9 | 30.6 | 7.71 | 11 8 | 5300 | | 13 | 1.12 | 3.47 | 14.7 | 8.4 |
| 920 | 6 | 3.8 | 30.2 | 7.85 | 11 26 | 5400 | | 14 | 1.15 | 3.64 | 15.0 | 8.3 |
| 915 | 6 | 3.7 | 29.9 | 8.00 | 11 43 | 5500 | | 14 | 1.18 | 3.81 | 15.3 | 8.3 |
| | | | | | | | | | | | | |
| 910 | 6 | 3.6 | 29.6 | 8.14 | 12 0 | 5600 | | 14 | 1.21 | 3.98 | 15.6 | 8.2 |
| 905 | 6 | 3.5 | 29.3 | 8.29 | 12 18 | 5700 | | 14 | 1.24 | 4.16 | 16.0 | 8.2 |
| 900 | 6 | 3.4 | 29.0 | 8.43 | 12 36 | 5800 | | 15 | 1.27 | 4.34 | 16.3 | 8.1 |
| 895 | 5 | 3.3 | 28.7 | 8.58 | 21 54 | 5900 | | 15 | 1.30 | 4.52 | 16.6 | 8.1 |
| 890 | 5 | 3.2 | 28.4 | 8.73 | 13 12 | 6000 | | 15 | 1.33 | 4.69 | 17.0 | 8.0 |

RANGE TABLE FOR 10-IN. R.M.L. GUN.

Based on Practice of 30.8.93, and on calculation.

Charge { weight, 44 lb.
gravimetric density, $\frac{47.1}{0.689}$.
nature, P.

Projectile { nature, common shell or Palliser shot.
weight, 410 lb.

Muzzle velocity, 1028 f.s.
Jump, 3 minutes.

| Remaining velocity. | To strike an object 10-ft. high, range must be known within | Slope of descent. | 5 minutes' elevation or deflection alters point of impact. | | Elevation. | Range. | Fuze scale for 15 secs. wood time. | 50 per cent. of rounds should fall in | | | Time of flight. | Penetration into wrought-iron. |
|---------------------|---|-------------------|--|--------------------------|------------|--------|------------------------------------|---------------------------------------|----------|---------|-----------------|--------------------------------|
| | | | Range. | Laterally or vertically. | | | | Length. | Breadth. | Height. | | |
| f.s. | yards. | 1 in | yards. | yards. | ° | yards. | | yards. | yards. | yards. | secs. | inches. |
| 1022 | 357 | 214 | — | 0.14 | 0 13 | 100 | | 9 | 0.06 | 0.04 | 0.29 | 9.4 |
| 1016 | 178 | 107 | 31.3 | 0.29 | 0 29 | 200 | 1.0 | 9 | 0.06 | 0.08 | 0.58 | 9.3 |
| 1010 | 117 | 70 | 31.9 | 0.43 | 0 45 | 300 | 1.5 | 9 | 0.06 | 0.12 | 0.83 | 9.3 |
| 1004 | 87 | 52 | 30.8 | 0.58 | 1 1 | 400 | 2.0 | 9 | 0.06 | 0.16 | 1.18 | 9.2 |
| 998 | 70 | 42 | 30.5 | 0.72 | 1 17 | 500 | 3.0 | 9 | 0.06 | 0.21 | 1.48 | 9.1 |
| 993 | 58 | 35 | 30.3 | 0.87 | 1 33 | 600 | 3.5 | 9 | 0.06 | 0.26 | 1.77 | 9.1 |
| 988 | 50 | 30 | 30.1 | 1.01 | 1 49 | 700 | 4.5 | 9 | 0.06 | 0.31 | 2.08 | 9.0 |
| 983 | 43 | 26 | 29.8 | 1.16 | 12 6 | 800 | 5.0 | 10 | 0.06 | 0.37 | 2.39 | 9.0 |
| 978 | 38 | 23 | 29.6 | 1.31 | 12 23 | 900 | 6.0 | 10 | 0.06 | 0.43 | 2.70 | 9.0 |
| 973 | 33 | 20 | 29.4 | 1.45 | 12 40 | 1000 | 6.5 | 10 | 0.06 | 0.50 | 3.01 | 8.9 |
| 968 | 30 | 18 | 29.2 | 1.60 | 2 57 | 1100 | 7.5 | 10 | 0.06 | 0.57 | 3.32 | 8.9 |
| 963 | 28 | 17 | 28.9 | 1.74 | 3 14 | 1200 | 8.0 | 10 | 0.06 | 0.66 | 3.63 | 8.8 |
| 958 | 25 | 15 | 28.7 | 1.89 | 3 31 | 1300 | 9.0 | 11 | 0.07 | 0.75 | 3.95 | 8.8 |
| 953 | 23 | 14 | 28.5 | 2.03 | 3 48 | 1400 | 9.5 | 11 | 0.08 | 0.83 | 4.27 | 8.7 |
| 948 | 22 | 13 | 28.3 | 2.18 | 4 6 | 1500 | 10.5 | 12 | 0.10 | 0.92 | 4.59 | 8.6 |
| 943 | 20 | 12 | 28.0 | 2.32 | 4 24 | 1600 | 11.0 | 12 | 0.12 | 1.03 | 4.91 | 8.6 |
| 938 | 18 | 11 | 27.8 | 2.47 | 4 42 | 1700 | 12.0 | 13 | 0.15 | 1.14 | 5.23 | 8.5 |
| 933 | 17 | 11 | 27.6 | 2.61 | 5 0 | 1800 | 12.5 | 14 | 0.18 | 1.27 | 5.56 | 8.5 |
| 928 | 16 | 10 | 27.4 | 2.76 | 5 18 | 1900 | 13.5 | 15 | 0.21 | 1.42 | 5.89 | 8.4 |
| 923 | 16 | 9.5 | 27.2 | 2.91 | 5 36 | 2000 | 14.0 | 16 | 0.25 | 1.68 | 6.22 | 8.4 |
| 918 | 15 | 8.9 | 27.0 | 3.05 | 5 54 | 2100 | 15.0 | 17 | 0.29 | 1.84 | 6.55 | 8.3 |
| 913 | 14 | 8.4 | 26.8 | 3.20 | 6 12 | 2200 | 16.0 | 18 | 0.33 | 2.11 | 6.88 | 8.3 |
| 908 | 13 | 8.0 | 26.6 | 3.34 | 6 31 | 2300 | 16.5 | 19 | 0.37 | 2.39 | 7.22 | 8.2 |
| 903 | 13 | 7.6 | 26.4 | 3.49 | 6 50 | 2400 | 17.5 | 20 | 0.40 | 2.68 | 7.56 | 8.2 |
| 898 | 12 | 7.2 | 26.2 | 3.63 | 7 9 | 2500 | 18.0 | 21 | 0.44 | 2.97 | 7.90 | 8.1 |
| 894 | 11 | 6.9 | 26.0 | 3.78 | 7 28 | 2600 | 19.0 | 22 | 0.48 | 3.26 | 8.24 | 8.1 |
| 890 | 11 | 6.6 | 25.8 | 3.92 | 7 47 | 2700 | 20.0 | 23 | 0.52 | 3.56 | 8.58 | 8.0 |
| 886 | 10 | 6.3 | 25.6 | 4.07 | 8 6 | 2800 | 20.5 | 24 | 0.56 | 3.90 | 8.93 | 8.0 |
| 882 | 10 | 6.0 | 25.4 | 4.21 | 8 25 | 2900 | 21.5 | 26 | 0.61 | 4.24 | 9.28 | 7.9 |
| 878 | 10 | 5.8 | 25.2 | 4.36 | 8 45 | 3000 | 22.0 | 27 | 0.66 | 4.65 | 9.63 | 7.9 |
| 874 | 9 | 5.6 | 25.0 | 4.51 | 9 5 | 3100 | 23.0 | 28 | 0.71 | 5.10 | 10.0 | 7.8 |
| 870 | 9 | 5.3 | 24.9 | 4.65 | 9 25 | 3200 | 24.0 | 29 | 0.76 | 5.60 | 10.3 | 7.8 |
| 866 | 9 | 5.1 | 24.7 | 4.80 | 9 45 | 3300 | 24.5 | 30 | 0.81 | 6.11 | 10.7 | 7.7 |
| 862 | 8 | 4.9 | 24.5 | 4.94 | 10 5 | 3400 | 25.5 | 31 | 0.86 | 6.62 | 11.1 | 7.7 |
| 858 | 8 | 4.6 | 24.3 | 5.09 | 10 25 | 3500 | 26.0 | 33 | 0.92 | 7.18 | 11.4 | 7.6 |
| 854 | 8 | 4.6 | 24.1 | 5.23 | 10 46 | 3600 | 27.0 | 34 | 0.98 | 7.63 | 11.8 | 7.6 |
| 850 | 7 | 4.4 | 23.9 | 5.38 | 11 7 | 3700 | 28.0 | 36 | 1.04 | 8.14 | 12.2 | 7.5 |
| 846 | 7 | 4.3 | 23.7 | 5.52 | 11 28 | 3800 | 28.5 | 37 | 1.10 | 8.74 | 12.5 | 7.5 |
| 842 | 7 | 4.1 | 23.5 | 5.67 | 11 49 | 3900 | 29.5 | 38 | 1.17 | 9.25 | 12.9 | 7.4 |
| 838 | 7 | 4.0 | 23.3 | 5.81 | 12 10 | 4000 | 30.0 | 39 | 1.24 | 9.75 | 13.2 | 7.4 |

DRILL.

10-IN. R.M.L. GUNS, IN CASEMATE OR OPEN BATTERIES.

A gun detachment consists of a Gun Captain, a Gun Layer, and nine other gun numbers.

It falls in and is told off as described in Garrison Artillery Drill, Part III., General Instructions.

For Gun Captain's and Gun Layer's duties *vide* Garrison Artillery Drill, Part III., General Instructions.

TO PREPARE FOR ACTION.

| <i>Gun Group Commander.</i> | <i>Gun Captain.</i> |
|-------------------------------|---------------------------|
| A GROUP "PREPARE FOR ACTION." | A 1 "PREPARE FOR ACTION." |

At "*Prepare for Action*" each number brings up his stores as under, assisted where necessary by the higher numbers.

Gun captain.—Key of hydro-clinometer when used.

Gun layer.—Sights, tubes, tube box, lanyards, prick, and vent server.

For drill, a drill tube.

No. 2.—Side arms.

No. 3.—Wedge wads, rammer rope, hoisting tackle, and traversing handles. (No. 5 assists, if necessary.)

No. 4.—Iron-pointed lever, elevating wheel, rammer rope, and assists No. 2 with side arms.

No. 5.—Iron-pointed lever and elevating wheel. Assists No. 3 if required.

No. 6, assisted by No. 10.—Bucket, filled, and brush. For drill, a zinc cylinder and drill cartridge.

Nos. 7 and 8, assisted by No. 9.—Transporting barrow and brush, 2 selvagees, fuzes, and fuze implements, automatic gas-checks as ordered (in boxes with the lids unscrewed), running back tackle and piece of chalk. For drill, a drill shell.

The following group stores are supplied, and should be laid down in the positions allotted to them:—

Cans, oil, lubricating, smith's; or cans, oil, lubricating, No. 9, 1 to 4 guns per work; hammers, 2 per battery command; spanner, hydraulic buffer, 1 per work (tension buffers are fitted with a permanent handle to the screw plug, to facilitate the release of air); spanners, McMahon, 1 per battery command; clinometers, 1 per group of guns; extractors, 2 per battery command; searchers, 1 to every 3 guns. These group stores will be brought up by the Nos. 6 and 7 of the guns they are intended for.

The Gun Layer receives the tubes from the shell store, straps the tube box round his waist on right side, and lays the lanyards over the caseable, placing the loop of the safety lanyard over, and the hook of the firing lanyard through, the lanyard guide. He fixes the sights, taking care that the fore sights fit correctly, and that the deflection leaves of the tangent sights work easily. He places the prick in the loop on the side of the carriage, examines the vent server and

places it in the vent with the loop over one of the hind sights, and sees that the pointer for traversing arc is let down. With P.F. he attaches the electric lanyard, coils it up, and places it in the safety-firing plug recess.

No. 2 places the sponge and rammer in the brackets on the right of the slide—the sponge head should be well clear of the water in the tank.

No. 3 puts on traversing handles and secures the hoisting tackle to the loading bar, overhauling it till the lower block is at a convenient height for hooking on to the selvage on the projectile; hooks the lower block to a loop on the left mantlet; removes the tampeon, placing it on the right of No. 5 when under cover, ships the port bar, places the wedge wads in a convenient position, and coils down the rammer rope clear of the racers. No. 5 assists if necessary.

No. 4 places the iron-pointed lever in its supports, puts on elevating wheel, coils down rammer rope clear of racers, and assists No. 2 with side arms.

No. 5 places the iron-pointed lever in its supports, puts on elevating wheel, and assists No. 3 if required.

No. 6 supplies the sponge tank with water; this should be well clear of the sponge when resting in the tank. Places the sponge bucket and brush on the left of No. 4's position when under cover. Loosens lids or removes bands from covers of cylinders as required, if not already done. At drill he places the zinc cylinder with drill cartridge at the head of cartridge lift, or outside cartridge store.

Nos. 7 and 8 place the transporting barrow, brush and selvagees at the head of the shell lift, or at the shell store, the automatic gas-checks in box, with lid unscrewed, close to No. 4. When wood time fuzes are used, they will place them, with hook borer, in a convenient position for the Gun Captain. They overhaul the running back tackle and place it in a convenient position in rear of the slide. At drill the drill shell is placed at the head of the shell lift or at shell store.

The Gun Captain now sees—

That the fuzes and fuze implements are ready to his hand.

That the gun itself is properly examined by the numbers whose duty it is to do so.

That the clip plates are secured to the carriage.

That the hydraulic buffer is properly filled, and piston rod connected up, and that a piece of paper is placed in the gas escape hole.

That the racers are clean, and that the tops of the side pieces of the slide are free from grease or moisture.

He receives reports from the numbers responsible of any irregularity or deficiency in connection with the different parts of the gun, carriage, slide, and stores.

When firing by position-finder he sees that the firing plug is ready for use, and that the electric lanyard is attached to the proper binding screws.

The Gun Layer drifts the vent and replaces the pricker and vent server.

No. 2 sees that the traversing gear is oiled and in working order, supplies himself with the searcher and, assisted by No. 3, searches the gun, taking care that the pricker is not in the vent, and replaces the searcher. He then supplies himself with the sponge and, assisted by No. 3, sponges out and replaces sponge.

No. 3 examines the bore to see that it is clear, and that the grooves are free from grit, and assists No. 2 to search and sponge out. The port bar will not be unshipped till the gun has been loaded.

Nos. 4 and 5 see that the elevating gear is oiled and in working order.

After each number has completed his work as above, he goes under cover.

The positions of the various numbers under cover are as follows. They should, if possible, be sitting or lying down.

Gun Captain.—Where he can best regain his position for superintending the working of his gun.

Gun Layer.—On the left of No. 4.

Nos. 2 and 4.—On the right of the gun.

Nos. 3 and 5.—On the left of the gun.

Nos. 2 and 3 being next the muzzle, and Nos. 4 and 5 outside them.

Nos. 6 and 10.—At the head of the cartridge lift, or outside the cartridge store.

Nos. 7, 8, and 9.—At the head of the shell lift, or outside the shell store.

TO LOAD.

| <i>Gun Group Commander.</i> | <i>Gun Captain.</i> |
|-----------------------------|---------------------|
| A GROUP OR A 1 .. "LOAD." | A 1 .. "LOAD." |

On this command, the Gun Layer mounts on the slide, connects a tube to the firing lanyard, adjusts his sight (except in Case III), and goes under cover or returns to sighting step. As soon as the gun has been run up, and the iron-pointed levers have been removed from their sockets, he will put the tube in the vent. When the gun is run up for the first time, he adjusts the safety lanyard, and fixes it to the sighting post, before putting the tube in the vent. For directions as to method of fixing and using safety lanyard, *vide* "Garrison Artillery Drill, Part III, General Instructions." When firing by Case I the tube is not to be put in the vent until the final range and deflection have been put on the sight, and if the safety lanyard is not used, not until the gun has been laid.

No. 3 moves into position, ships port bar (if used),* withdraws the cartridge from the cylinder with his left hand, resting it in the hollow of his right arm, and places it in the bore, choke to the front.

Nos. 6 and 10 supply a cartridge to No. 3 (No. 6 bringing up the cylinder on his left shoulder, lid to the rear) and standing to the right rear of No. 3.

No. 2 receives an automatic gas-check from No. 4 and places it in the bore (at drill going through the motion only), with the painted side towards the cartridge.

Nos. 7, 8, and 9 bring up the projectile on its barrow. No. 5 casts loose the lower block of the hoisting tackle and hands it to No. 2, and passes the running end through the snatch block.

No. 3 shifts the upper block till it is over the muzzle; No. 2 hooks the lower block into the selvagee round the projectile; No. 3 then gives the signal to "*Hoist away*" by raising his right arm straight above his head. Nos. 2 and 3 steady and guide the projectile, No. 2 attending to the lower block, and No. 3 to the upper block of the tackle. No. 3 shifts the empty barrow clear of the hoisting numbers, No. 7 removing it altogether after the projectile has been rammed home.

* For first round the port bar is shipped at "*Prepare for action*," and not unshipped until the gun has been loaded.

The projectile is raised by the following numbers—5, 6, 7, 8, 9, and 10. The numbers manning the hoisting tackle should stand as close to the slide as possible.

When the projectile is high enough, No. 3 again raises his arm above his head, and with No. 2 forces the projectile into the bore. No. 3 again raises his arm and waves his hand across. The hoisting numbers then ease off. No. 2 casts loose the solvagee and throws it on to the barrow, and, assisted by No. 3, forces the projectile well into the bore. He then receives the rammer from No. 4. No. 3 uncaps or removes the safety pin from the fuze and pushes the tackle clear. No. 4 supplies the rammer with the right rammer rope attached. No. 3 hooks the left rammer rope, and with No. 2 steadies the rammer stave.

The rammer ropes are manned by—

| | | | | |
|------------|----|----|----|-------------------|
| Right side | .. | .. | .. | Nos. 4, 6, and 8. |
| Left | „ | .. | .. | Nos. 5, 7, and 9. |

Nos. 2 and 3 raise their arms, and the projectile is rammed home. When home, Nos. 2 and 3 again raise their arms, detach the rammer ropes and hand them to Nos. 4 and 5, who coil them down clear of the working of the gun; they then spring the rammer.*

No. 3 inserts a wedge wad, and Nos. 2 and 3 press steadily home, jamming it under the head of the projectile with two smart taps (at drill going through the motion only); the rammer is then sprung and replaced by No. 2; No. 5 overhauls the hoisting tackle, hooking the lower block into loop on left mantlet, and No. 3 unships the port bar.

The Gun Captain now gives the signal to "*Run up*," by raising both arms vertically above his head.

At this signal Nos. 4 and 5 put their iron-pointed levers in the sockets and bear down; should the gun run up too rapidly, they raise their levers and check it.

When the gun is run up, the Gun Captain signals "*Halt*," by holding up his right hand; Nos. 4 and 5 raise their levers till the sockets touch the stop plates, and replace them.

Nos. 2 and 3, assisted by 9 and 10, close the mantlets.

TO LAY AND FIRE.

See Garrison Artillery Drill, Part III, Section I, General Instructions.

Nos. 2 and 3, assisted by Nos. 9 and 10, man the traversing handles and remain on them till the gun is fired. Nos. 4 and 5 man the elevating wheels.

In Case I, after having set his sight to the final range, the Gun Layer inserts the tube in the vent.

TO SPONGE OUT.

After firing the Gun Layer replaces the vent server, examines the safety lanyard, or with position-finder Case III coils up the lanyard and puts it in the firing plug recess or suspends it from the roof out of the way of the detachment. Nos. 4 and 5, assisted by 9 and 10, attend to the mantlets. No. 3 ships the port bar. No. 4 supplies the sponge. No. 2 and 3 sponge out the gun. No. 4 replaces the sponge.

* Should the projectile be "*not home*," Nos. 2 and 3 raise their arms and wave their hands twice across; the projectile is then forced home. A brass screw on the rammer stave shows when the full charge and common shell are "*home*." If a different charge or projectile of a different length is being used, the rammer must be marked accordingly.

TO RUN BACK AND UNLOAD AT DRILL.

As soon as the gun has been fired, the Gun Layer having replaced the vent server, the Gun Captain gives the signal to run back by holding up both arms vertically above his head.

He then disconnects the traversing gear by shifting and keying up the handle, Nos. 6 and 7 fix the running back tackle, take two turns round the bollard, and hold on to the fall. Nos. 4 and 5 then apply their levers and bear down, Nos. 2 and 3 attending to the pawls. The traversing handles are manned by—

Nos. $\begin{cases} 2, 4, \text{ and } 10 \\ 3, 5, \text{ and } 9 \end{cases}$

The Gun Captain raises his right arm and the numbers heave round, the Gun Captain following up the right front roller with a wedge wad, the Gun Layer attending to the safety lanyard. As soon as the gun is back, the Gun Captain again raises his right arm.

Nos. 4 and 5 then apply their levers and bear down; Nos. 6 and 7 remove the tackle; the Gun Captain shifts the gear to traversing.

The numbers (except 4 and 8) remain on the traversing handles until the carriage is lowered.

The gun is unloaded by the same numbers who loaded it, No. 3 shipping the port bar, and No. 4 supplying extractor and searcher.

As soon as the gun is unloaded No. 4 supplies the sponge, and Nos. 2 and 3 sponge out.

TO CEASE FIRING AND REPLACE STORES;

TO TAKE POST UNDER COVER; and

TO FORM DETACHMENT, REAR.

Vide Garrison Artillery Drill, Part III, Section I, General Instructions.

DRILL FOR 10-IN. GUNS IN BARBETTE BATTERIES.

(With Sunken Ways.)

The guns are fitted with muzzle derricks and supplied with loading stages.

The running end of the fall of the hoisting tackle is led through an 8-in. snatch block, which is hooked into a permanent eye let into the wall of the parapet.

Two metal blocks are hooked into the loops or eyes on the derrick, and the rammer ropes are passed through them. The snatch blocks are hooked for loading by No. 4 and 5, unhooked by them after the projectile has been rammed home, and laid down with the rammer ropes.

The drill is the same as for guns mounted in casemates, with the following exceptions:—

TO PREPARE FOR ACTION.

There are no mantlets and no port bar.

No. 3, spun yarn, with which he mouses the upper block of the hoisting tackle, which he then overhauls.

No. 5 an 8-in. single block, through which he passes the running end of the fall of the hoisting tackle, and two 4-in. snatch blocks, through which he passes the rammer ropes.

No. 7.—Tackle for hoisting projectile on to loading stage. (When the projectile to be used is known, it would be placed on the stage at "*Prepare for action.*")

TO LOAD.

The cartridge and projectile are brought up on opposite sides of the gun.

Nos. 4 and 5 raise the derrick; after the projectile has been rammed home, they throw back the derrick.

No. 5 rounds in the tackle, chock-a-block, the running end of the fall being left on the ground close to the leading block, and free to run on the recoil of the gun.

Nos. 7 and 8, assisted by 9 and 10, place a projectile on the loading stage. They run it under the muzzle of the gun, and after the gun has been loaded remove it.

With guns that are run up by levers, with ropes attached, Nos. 4 and 5 place the iron-pointed levers in the sockets and lay them down when the gun is run up; Nos. 2 and 3 man the lever ropes and bear down. Should they observe the gun running up too quickly they will come up on the ropes.

After the gun has been fired, Nos. 7 and 8 run the loading stage under the muzzle, removing it after Nos. 2 and 3 have sponged out.

If no crane or derrick is available for lifting the projectile on to the loading stage, it can be rolled up on a plank. In such cases the fuze should be fixed after the shell is on the stage.

The detail relating to the transporting barrow does not apply to this drill, and is only used for conveying projectiles to the loading stage.

N.B.—For guns mounted "*en barbette*," without sunken way, a transporting barrow is used for the conveyance of projectiles to the muzzle of the gun, instead of the loading stage.

DRILL FOR 10-IN. GUNS IN BARBETTE BATTERIES WITH FIXED LOADING STAGES.

(With Sunken Ways.)

The slides are fitted with loading derricks and stages (one derrick to be kept in store, also the opposite winch handle and brake, the derrick post is to be left on the slide). The running end of the fall of the hoisting tackle is led through a snatch block, which is hooked to the foot of the derrick. Two guides for rammer ropes are attached to the carriage; snatch blocks are therefore not required.

The drill is the same as for 10-in. mounted in casemates, with the following exceptions;—

TO PREPARE FOR ACTION.

No. 3 brings up spun yarn, with which he mouses the upper block of hoisting tackle, which he overhauls, placing the lower block on the loading stage. Nos. 4 and 5 pass the rammer ropes through the guides on the carriage.

TO LOAD.

The cartridge and projectile are brought up on opposite sides of the gun.

Nos. 2 and 4 or 3 and 5 (on their own sides) attend to the loading derrick, No. 2 or 3 fixes the catch to secure derrick to post for loading, No. 8 hooks lower block of hoisting tackle. After the projectile has been rammed home, Nos. 2 and 4 or 3 and 5 lower the derrick.

The projectile is brought up, as with guns in casemates, on the right or left of loading stage, depending on which side the derrick is used.

TO RUN UP.

The Gun Captain will give "*Stand clear*"; as soon as all the numbers are clear from the front of the iron-pointed levers he will give the signal to "*Run up*." Nos. 4 and 5 then haul down the check ropes on their iron-pointed levers, walking round the drum as the gun runs up.

DRILL FOR 10-IN. R.M.L. GUN ON HIGH ANGLE MOUNTINGS, MARKS I, II, AND III.

The drill is the same as that for 10-in. guns on casemate mountings, with the following exceptions:—

The detachment consists of Gun Captain, Gun Layer, and 7 other gun numbers.

TO PREPARE FOR ACTION.

Gun Layer.—Rimer and tube extractor, instead of pricker and vent server; the gun being always laid by Case III, sights are not used, nor are iron-pointed levers, wedgo wads, or running back tackles required.

No. 3.—Pressure indicator and spanners.

No. 4.—Instrument for nicking on gas checks.

No. 8.—One set of hoisting tackle.

The Gun Captain will see that the roller path is clean, he will attach the pressure indicator, and test the pressure in the cylinders, and test the level of liquid in each cylinder. (For method of charging and testing cylinders, *vide* p. 18 and 19). He will see that the clip plates are secured to the mounting.

The Gun Layer lifts up the hinged cover of the vent, inserts an electric P tube (tubes electric, V. S., *with ball* are not to be used with these guns when the chamber is empty, as they have been found to damage the bore), lowers the hinged cover and secures it with the keep pin. He then fires the tube before the gun is searched. The Gun Captain being careful to see that no one is in front of the gun when the tube is fired; he will also be responsible that no charge is in the gun.

There being no vent server with this gun, the old tube is always to be in the vent during sponging out and loading.

No. 2 sees that the trolley is in good working order.

No. 6 places the sponge bucket close to the sponge head.

Nos. 7 and 8 hook the upper block of the hoisting tackle to the derrick and mouse the hook, overhauling the tackle until the lower block is in a convenient position for hooking into the selvagee round the projectile.

TO LOAD.

The Gun Layer connects up an electric tube to the lanyard, and, after the rammer has been withdrawn and Nos. 2 and 3 are off the parapet, he places the tube in the vent, seeing that the lanyard is hanging so that it will not be cut by the recoil of the gun.

Nos. 2 and 3 mount on the parapet. No. 3 withdraws the cartridge from the cylinder and places it in the bore choke to his left; No. 6 supplies the cartridge to No. 3 and stands close to the parapet on the left side of the mounting, No. 5 assisting No. 6; No. 6 replaces empty cylinder. No. 2 receives the rammer from No. 4, and with No. 3 runs home the cartridges carefully, the rammer on withdrawal being rested between the parapet and mounting.

Nos. 7 and 8 bring up a projectile on its barrow; No. 4 or 5 (if the derrick is on the left side of the emplacement) hooks the lower block

of the tackle to the selvagee round the projectile and nicks on the gas check; No. 2 then gives the signal "*Hoist away.*"

The projectile is raised by Nos. 4, 7 and 8, or 5, 7 and 8, according to which side the derrick is; the running end of the fall being led to the front, close to the parapet, and the direction of the pull from the head of the derrick being such that the hoisting numbers are not under the weight. When the projectile is high enough No. 2 again raises his arm above his head, and, with No. 3, forces the projectile on to the loading trolley. No. 2 again raises his arm and waves it across. The hoisting numbers then ease off; No. 2 casts loose the selvagee and throws it on the barrow. Nos. 2 and 3 then move the trolley round in front of the muzzle; No. 3 uncaps or removes the safety pin from the fuze, then releases the projectile. Nos. 2 and 3 ram it home and withdraw the rammer, and No. 2 hands it back to No. 4, who replaces it. Nos. 2 and 3 then place the trolley on one side clear of the muzzle, and dismount off the parapet. No. 7 removes the barrow and selvagee. No. 8 overhauls the hoisting tackle.

NOTE.—The gun runs up to the firing position immediately after recoil.

TO LAY AND FIRE.

See Case III, General Instructions, Garrison Artillery Drill, Part III, Section I.

TO SPONGE OUT.

On account of the division of the charge into quarter charges, there is an increased risk of residue of silk cloth being left in the bore; it is therefore necessary that the operation of sponging out should be *carefully and thoroughly performed.*

TO CEASE FIRING AND REPLACE STORES.

The Gun Captain sees that the gun is depressed until the muzzle touches the parapet.

DRILL FOR GUNS ON SMALL PORT CARRIAGE.

The drill is the same as for guns in casemates, with the following exceptions:—

TO PREPARE FOR ACTION.

No. 10 brings up handles of following-up gear.

Gun Captain will see that the ram is in good order.

TO RAISE THE GUN BY RAM.

PREPARE TO RAISE THE GUN.

RAISE THE GUN, "HALT."

Nos. 2, 3, 4 and 8 man the pump lever handles of the ram on their own sides; Nos. 6, 10, 7 and 9 the winch handles of the quick-motion screw for following up (on their own sides).

RAISING THE GUN BY SCREW LIFT.

In the event of failure of the hydraulic ram, the slow motion screw must be worked. This will require four numbers on each handle, to be relieved when necessary.

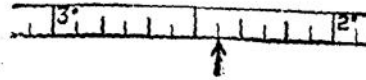
N.B.—The gun captain attends to the release valve, and must be careful after each change of position of the gun and *before firing* that the release valve is open until the gun rests on the trunnion blocks, when it should be again closed.

The sponge and rammer being slung from the roof, No. 10 will assist No. 4 to supply and replace them.

INSTRUCTIONS FOR USING WATKIN'S CLINOMETER.

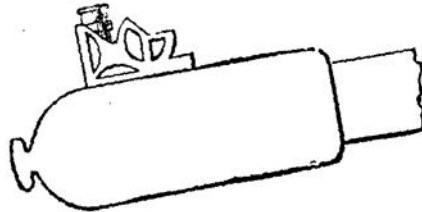
To read the angles marked on the drum.—The brass drum is marked in degrees, commencing at 0° on the top to 45° at the bottom. Each degree is subdivided into twelve parts; each small division therefore represents angles of 5 minutes.

The scale is read from right to left, thus—



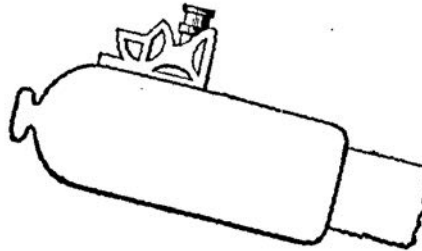
the reading opposite the arrow would indicate an angle of $2^\circ 25'$.

To lay a gun at any angle up to 45° .—Unscrew the drum, until the \uparrow points to the elevation required, place the clinometer, thus—

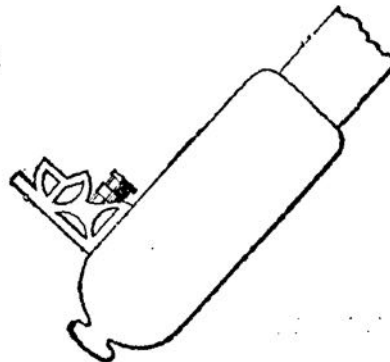


on the plane surface cut on the breech, and elevate the piece until the bubble of the spirit-level is in the centre of the tube.

For angles of depression.—Proceed as above, but reverse the direction of the instrument, placing it thus on the breech of the gun—



For angles of elevation greater than 45° .—Subtract the angle of elevation required from 90° , unscrew the drum to this reading; thus, for 60° , unscrew the drum to 30° , and place the instrument on the breech of the gun and elevate until the bubble is in the centre of its run, thus—



INSTRUCTIONS FOR THE CARE AND PRESERVATION OF RANGE-FINDERS.

1. Depression range-finders, of the following descriptions, are allowed for coast batteries having an elevation of 25 ft. and upwards above high-water mark:—

| | |
|------------|-----------------------------|
| Mark I. | for batteries 85 to 190 ft. |
| Mark I.A. | „ 60 to 110 ft. |
| Mark I.B. | „ 110 to 240 ft. |
| Mark I.C. | „ 240 to 550 ft. |
| *Mark I.D. | „ 30 to 60 ft. |
| Special | „ at other heights. |

2. The instruments will be taken on charge by the officer in charge of the Armament district, who will be held responsible for their condition.

3. The range-finders *in works at home* will be periodically inspected by the Chief Inspector of Position-finding, or an Officer deputed by him, when such inspection is recommended by the Instructor in D.R.F. at the various stations.

4. The instruments found defective after such inspection will be sent for repair, through the Chief Ordnance Officer, to the Principal Ordnance Officer, Woolwich, who will transmit them to the Chief Inspector of Position-finding. The instruments will be returned through the same channel. The Chief Inspector of Position finding will communicate direct with Officers Commanding Royal Artillery concerned, as to when these instruments are to be sent for inspection. As far as possible the inspection should be carried out during the winter months.

5. At stations abroad, when it is necessary to send range-finders home for inspection by the Chief Inspector of Position-finding, instruments should be demanded in advance to replace those it is proposed to send home. On receipt of the new instruments the defective ones should be forwarded for examination and repair.

6. A history sheet in duplicate will be prepared for each range-finder, and every transaction connected with the instrument will be entered on these sheets (*see specimen page 60*). One copy will accompany the instrument to which it relates on all occasions of inspection or return to store; the other will be retained by the Chief Inspector of Position-finding.

7. When instruments in Army Ordnance charge require examination, the Chief Inspector of Position-finding is to be communicated with as to time and place of inspection.

8. When an instrument is sent to the Principal Ordnance Officer for repair or inspection, a report of the condition of the instrument will be sent with it, thus:—

- (a) Condition of No. _____ instrument.
- (b) Is the instrument in good order, and does it give correct ranges?
- (c) If not, explain reason.

9. If the instrument has been damaged, full particulars of how the damage occurred should be stated.

10. To pack the instrument for transport—

- (a) Push the slide from the end of the bar furthest from the pivots.
- (b) Screw up the drum to the zero position.
- (c) Tie several turns of tape round the telescope arm and the body of the instrument so as to keep these parts from moving.

* This instrument has a screw and drum arrangement different from that of other marks.

N.B.—In old pattern cases, in which the range-finder was fixed to a woollen slide, the telescope should be removed and placed in the special box in which it was sent to the station.

11. The boxes containing the instrument and telescope should be packed in a strong box with hay, and marked "Glass with care," the lid being screwed down, not nailed.

12. The range-finder, when not in use, should be kept in a dry place.

13. Instruments, when taken out for instruction or practice, should be in the immediate charge of a qualified officer or non-commissioned officer, and before passing out of his charge should be carefully inspected.

14. On no account should an unqualified man attempt to set up or use the range-finder.

15. The steel parts of the instrument and the large screws should be occasionally oiled, but the oil must be wiped off again; an accumulation of oil is liable to cause particles of grit to adhere and damage the working parts.

16. The object-glass and eye-piece should be occasionally carefully cleaned with a *perfectly clean soft* piece of chamois leather, which should be used for no other purpose.

17. It is not advisable, unless absolutely necessary, to remove the object-glass or eye-piece.

18. Should it be necessary to remove the object-glass, great care must be exercised that the two lenses are replaced correctly, the marked surfaces being placed together, also that the cell is carefully screwed up into exactly the same position, and the instrument tested for collimation again.

19. If the eye-piece is removed, great care should be taken that the fine spider's web which will be then exposed is not damaged.

20. Care should be exercised in ascertaining that the distances of the datum points are correct, and it is very desirable that one of these points should be near the extreme right, the other near the extreme left training.

21. Should the instrument when set on one datum point not give the correct distance of the other datum point the instrument should be examined to see if it is properly levelled and in adjustment. If these are correct, the distance of the datum points should be verified from a map, or application be made to the Royal Engineers to measure the distances.

22. The issue of instruments, approved for new positions, will be accompanied in each case by a base plate and cover.

23. These, which are somewhat similar to the head of the range-finder tripod, are secured with cement on the work.

24. Instruments once levelled on to a base plate, if carefully taken off when returning to box, will require no adjustment when again set up for use.

25. Covers with padlock will be provided for use with the base plate to protect them from the weather.

26. On no account should any attempt be made to repair the instruments locally, except under the orders of a qualified range-finding instructor or a position-finder inspector. These officers will exercise their discretion as to the repairs which can be carried out locally under their own immediate supervision with the appliances available; but the nature of these repairs should be inserted in the history sheets.

SPECIMEN FORM OF HISTORY SHEET.

Army Form G 920.

| | | | | |
|---------------|--------------------------|-------|---------|---------------|
| Description { | Depression Range-finder. | Mark. | Number. | Manufacturer. |
| | Field " " | " | " | " |
| | " Mekometer. | " | " | " |
| | " Telemeter. | " | " | " |

Inspection before Acceptance. Date. _____ Signature of Inspecting Officer. _____

| Issues and Exchanges. | | | | Date. | Inspections. Occasion. | Inspections. | | Repairs. | | Signature of Officer who makes the entry.* |
|-----------------------|----------------------------|----------------------------|---|----------|---------------------------|-----------------------------------|----------------------|----------|---------------|--|
| Date. | From. | To. | For. | | | Remarks of Inspecting Officer. | Recom- mendation. | Date. | By. | |
| 5.1.97 | P.O.O. .. | C.R.A. Western District | Service .. | .. | .. | .. | .. | .. | .. | H.W. |
| 20.11.97 | C.R.A. Western District | P.O.O. .. | Inspection.. | 4.12.97 | Annual .. | Good order .. | Service .. | .. | .. | |
| 10.12.97 | P.O.O. .. | C.R.A. Western District | Service .. | .. | .. | .. | .. | .. | .. | |
| 8.6.98 | C.R.A. Western District | P.O.O. .. | Repair of cross wires | 20.6.98 | After repairs | Good order .. | Service .. | 12.6 | Smith .. | |
| &c. | &c. | &c. | &c. | &c. | &c. | &c. | &c. | .. | .. | |
| 10.10.98 | C.R.A. Western District | P.O.O. .. | Repair, blown down, placed too near gun | 17.10.98 | Inspection.. | Damaged repair beyond | Struck off charge | .. | 84 W .. | .. |

* First line of heading will be filled in by P.O.O.

Second line by Inspecting Officer.

Remaining entries will be made as follows :—

Issue to batteries, or to C.O.O. abroad by P.O.O., also name
of instrument-maker who executes repairs.

Returns to Store, by officer returning the instrument.

Inspections by Inspecting Officer.

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ORDNANCE, R.M.L., 10 INCH, MARK II, 18 TON.

SECTION OF GROOVE.
Full Size.

1. B. COIL
A. TUBE (TOUGH STEEL)
B. TUBE
BRECH PIECE (COILED)
C. COIL
CASCABLE SCREW

145.5 Length of Bore

180 Total Length of Gun

Note:— These guns for Land Service are vented upon the right-hand side at an angle of 45° with the vertical axis of gun.

Full Size.

Note:- These guns for Land Service are vented upon the right-hand side at an angle of 45° with the vertical axis of gun.

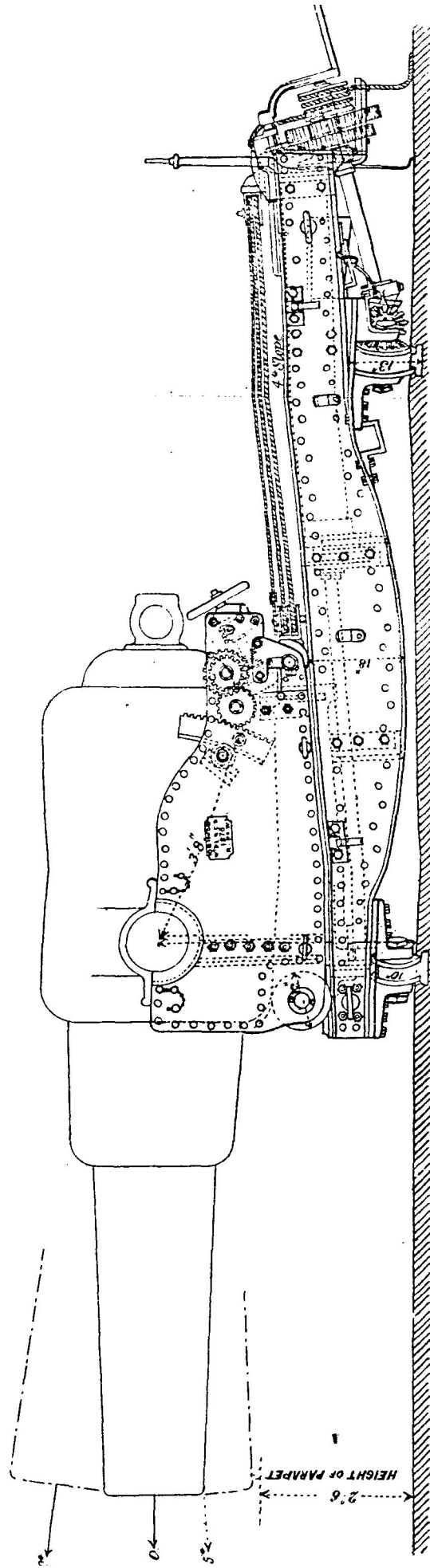
Plato 1

Wyman & Sons, Ltd. Lith. 3295, y. 59

CARRIAGE, GARRISON, R. M. L., 10 INCH, CASEMATE OR DWARF.

SLIDE, L. R. M. L., 10 INCH, CASEMATE.

REAR.



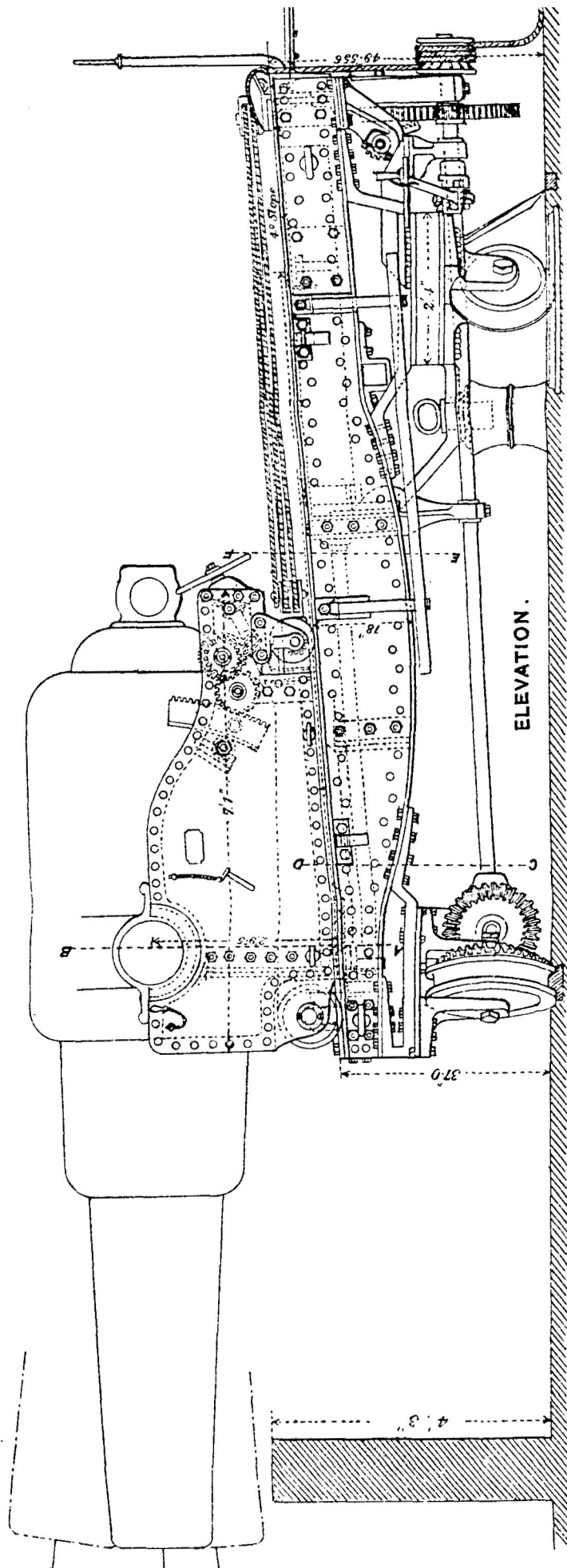
CARRIAGE, GARRISON, R. M. L., 10 INCH, CASEMATE, OR DWARF.

SLIDE, L. R. M. L. 10 INCH, DWARF. "D."



A vertical scale bar with markings from 0 to 7 feet. The markings are labeled 'Inches' at the bottom and 'Feet' at the top. The scale is divided into 12-inch increments, with each inch further subdivided into smaller units.

7 Feet



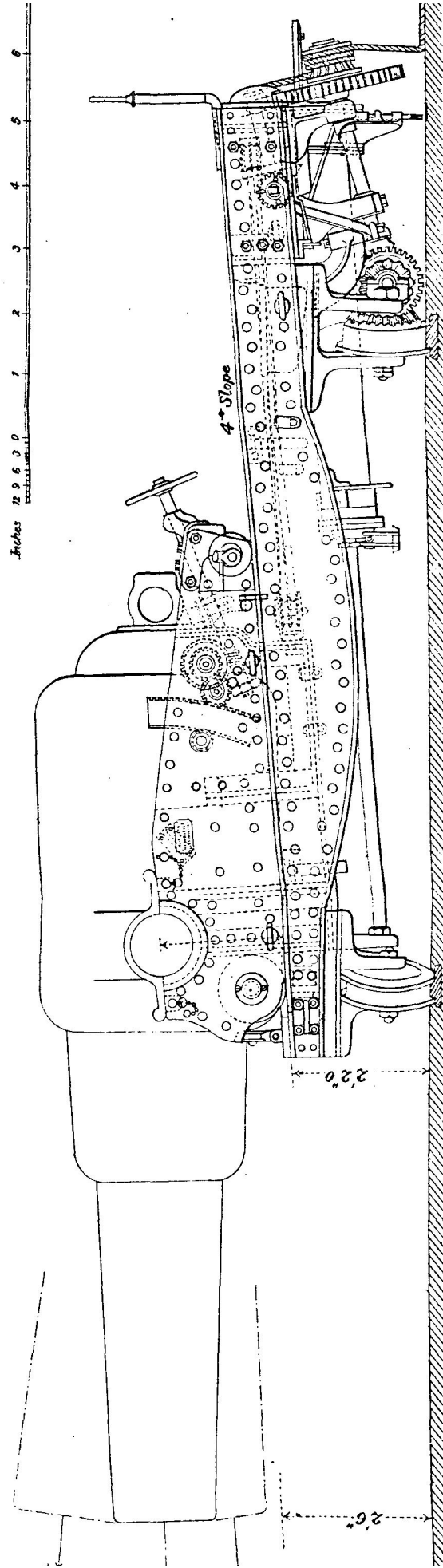
CARRIAGE, GARRISON, R. M. L., 10 INCH., MARK II.

SLIDE, L., R. II. L., 10 INCH, CASEMATE, MARK II.

SCALE

Inches 12 9 6 3 0

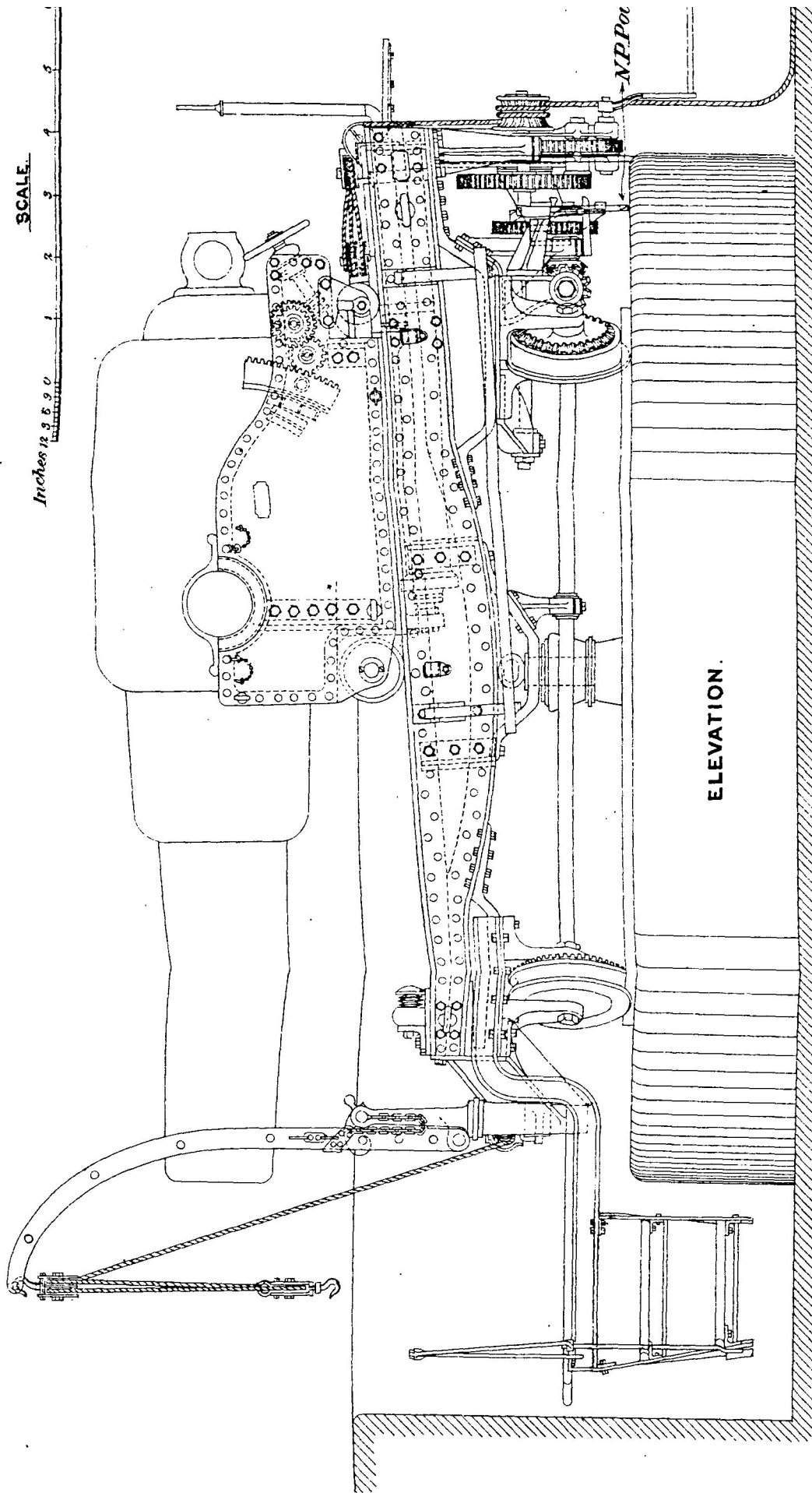
1 2 3 4 5 6



ELEVATION.

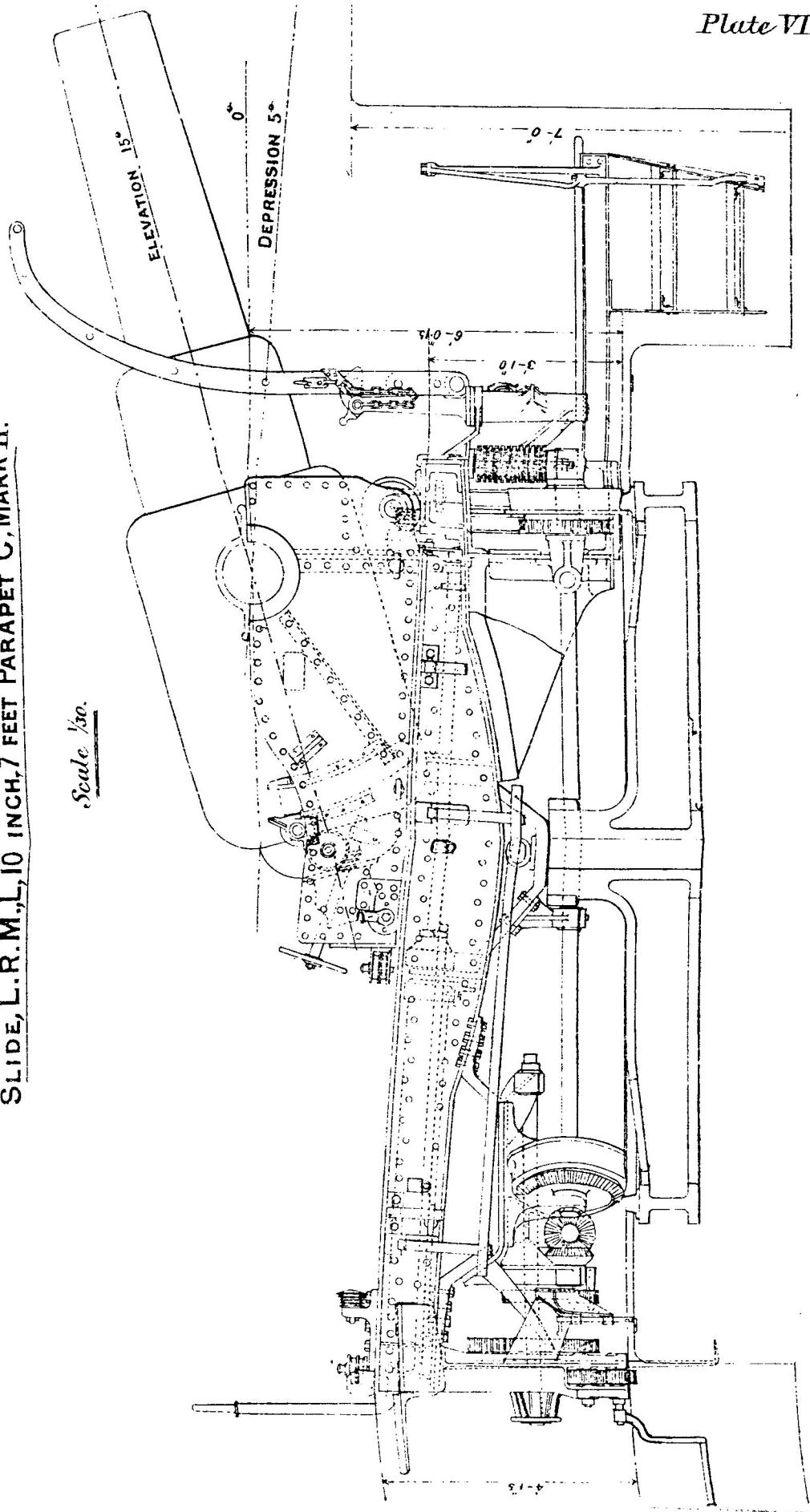
CARRIAGE, GARRISON, R. M. L. 10 INCH, CASEMATE OR DWARF.

SLIDE, L. R. M. L. 10 INCH, 7 FT. PARAPET, C., MARK I.

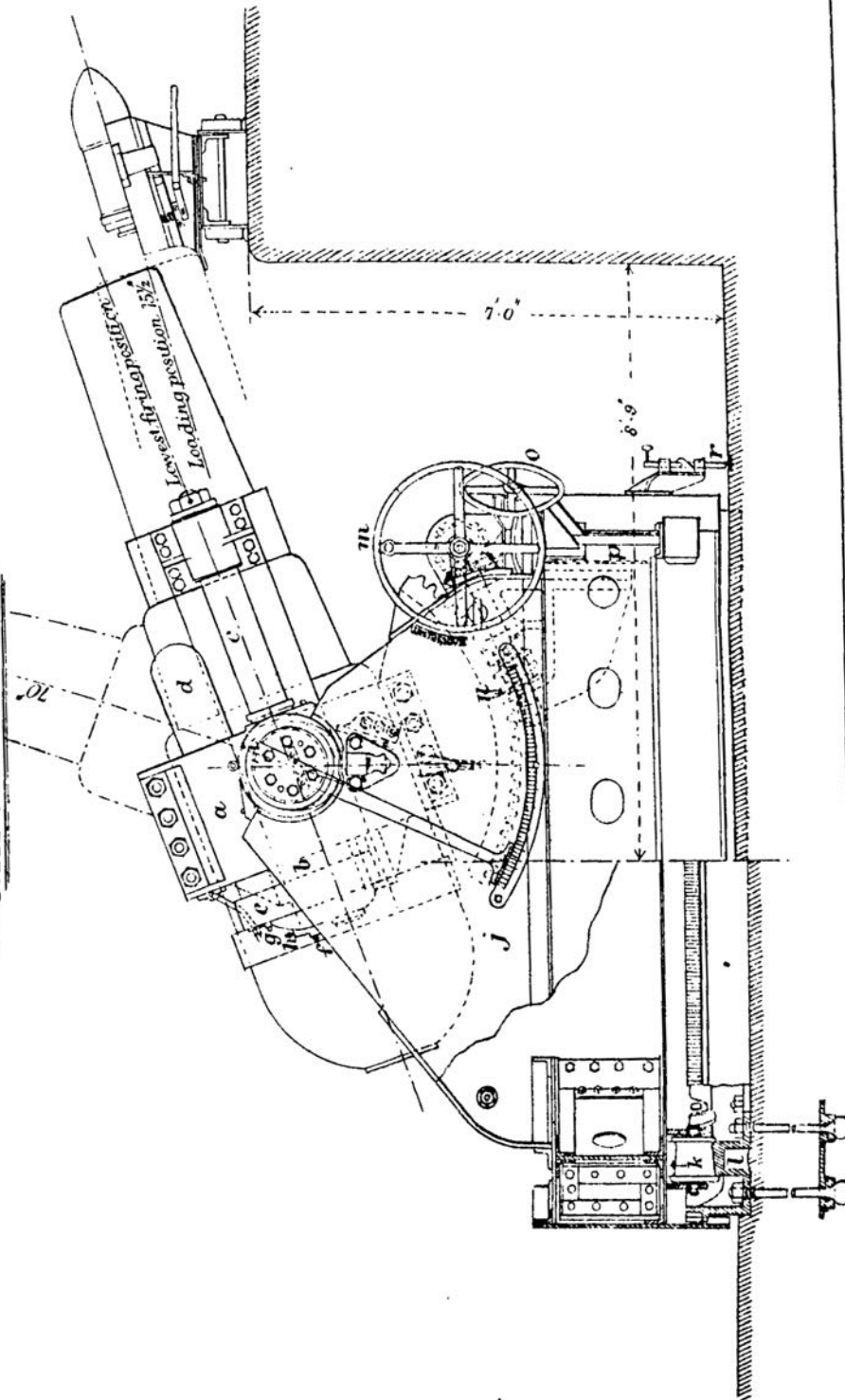


CARRIAGE, GARRISON, R. M. L., 10 INCH, MARK III.
 SLIDE, L. R. M., L., 10 INCH, 7 FEET PARAPET "C", MARK II.

Scale $\frac{1}{30}$.

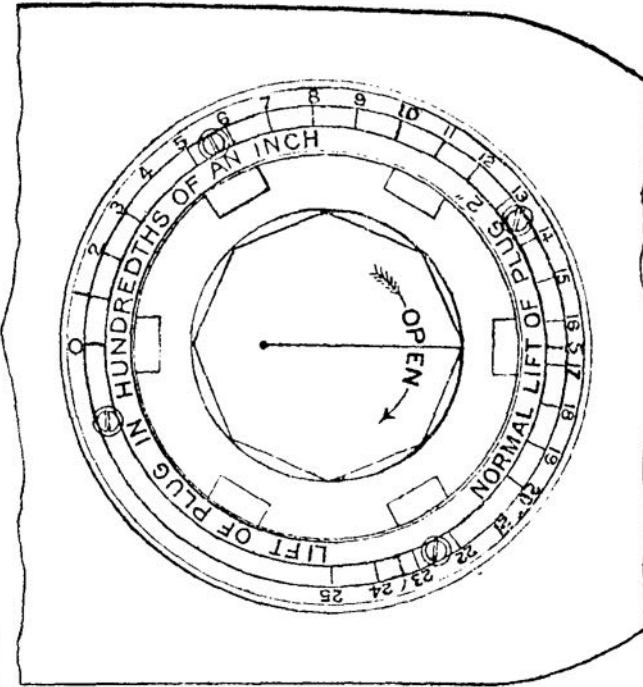
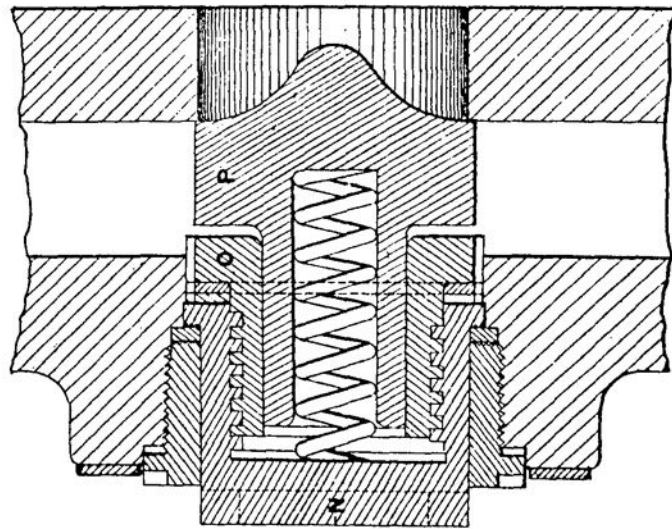


CARRIAGE, GARRISON, R. M. L., 10-INCH, HIGH-ANGLE, MARK III.
— STEEL WITH ROLLER RING



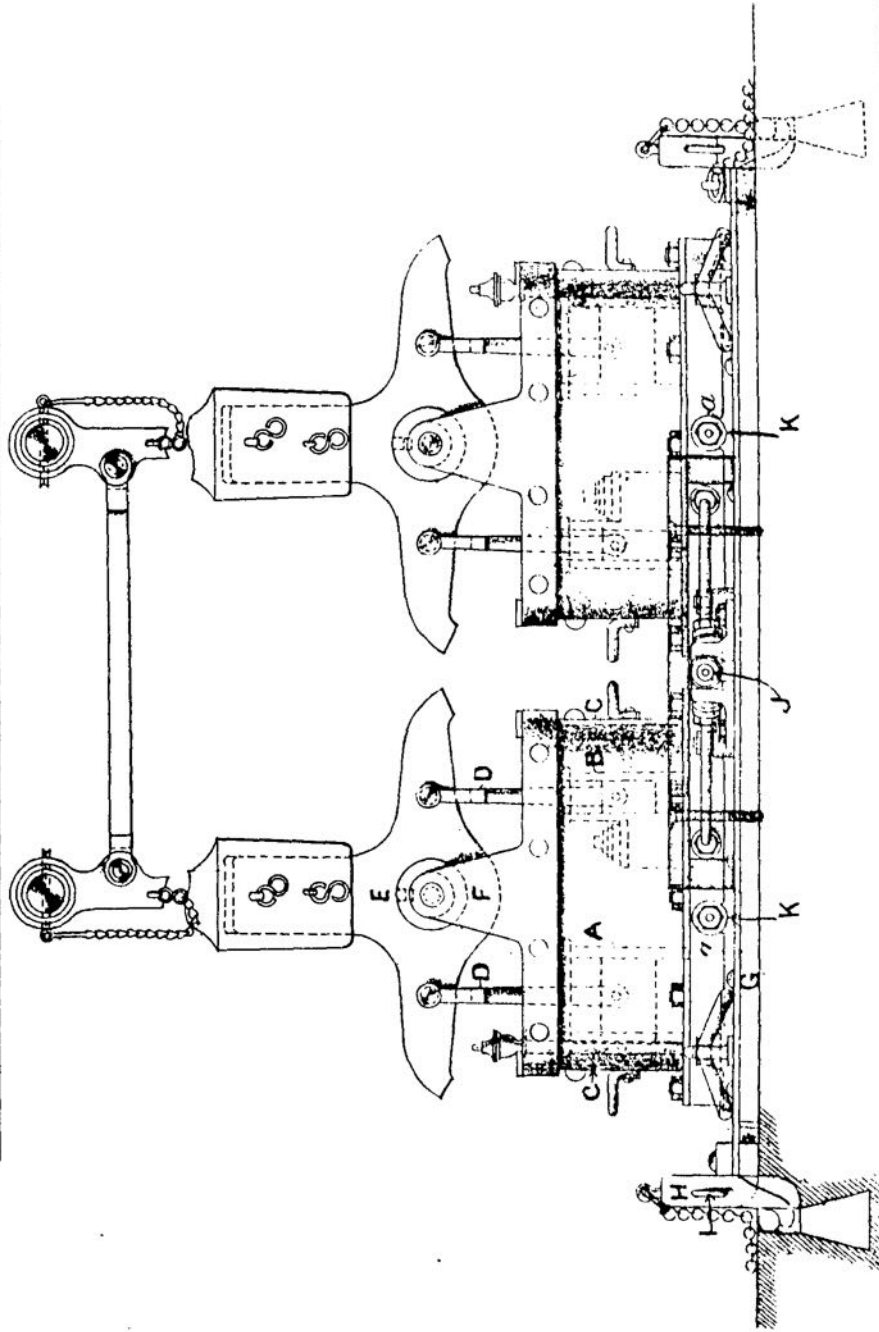
CARRIAGE, GARRISON, R.M.L., HIGH-ANGLE, 9 & 10 INCH, MARK III.

Scale $\frac{2}{5}$ in.

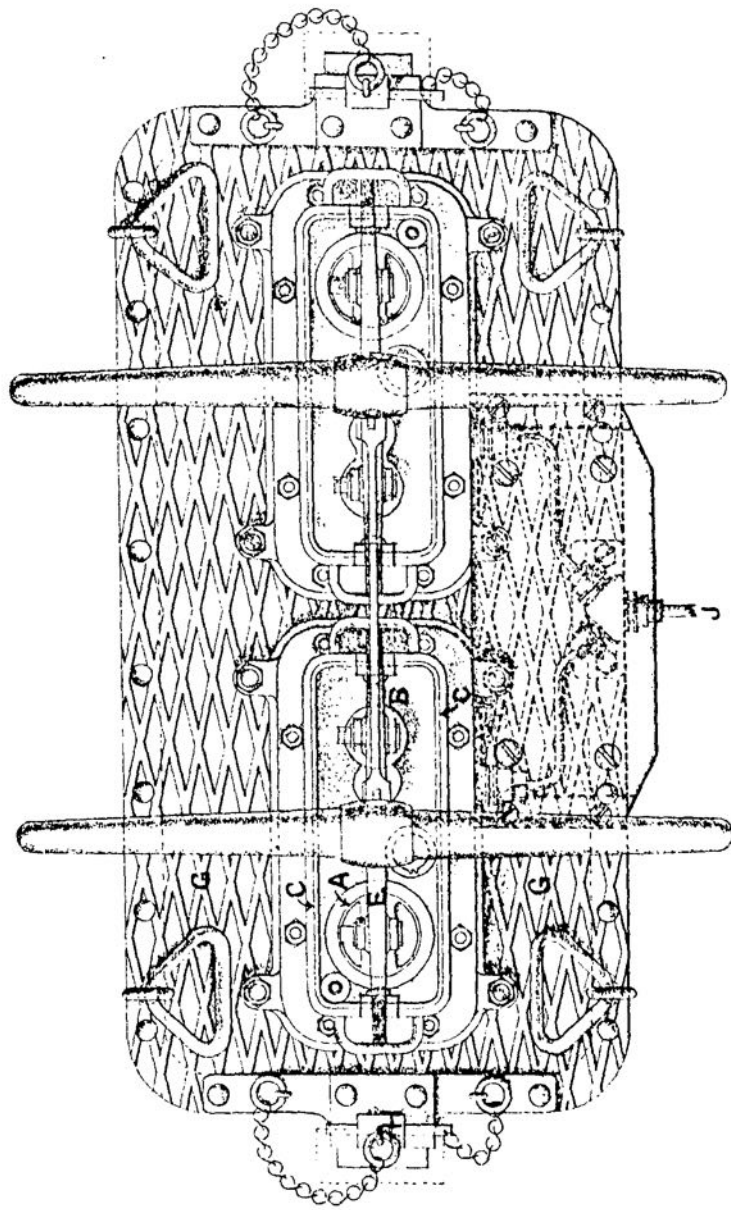


VALVE RECOIL.

PUMP, AIR, DOUBLE, CARRIAGE, GARRISON, HYDRO-PNEUMATIC, MARK I.

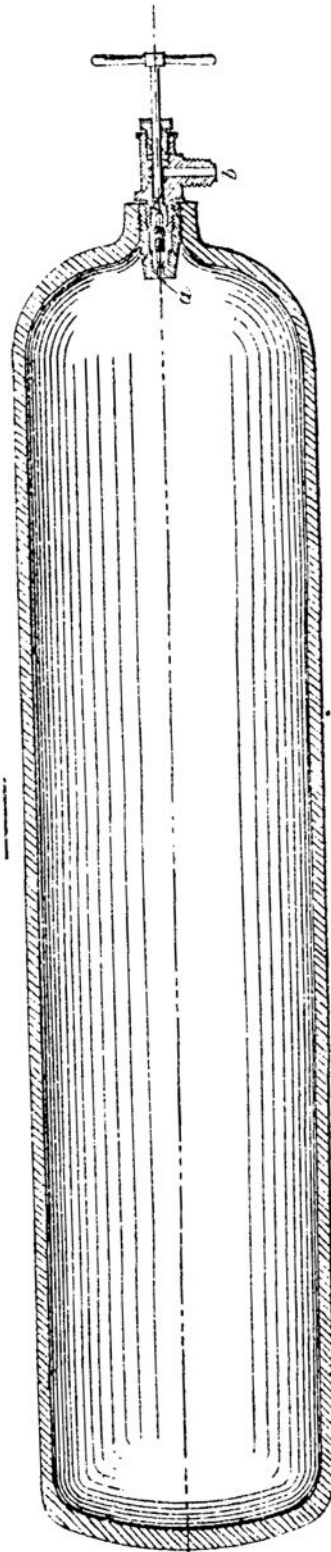


PUMP, AIR, DOUBLE, CARRIAGE, GARRISON, HYDRO-PNEUMATIC, MARK I.

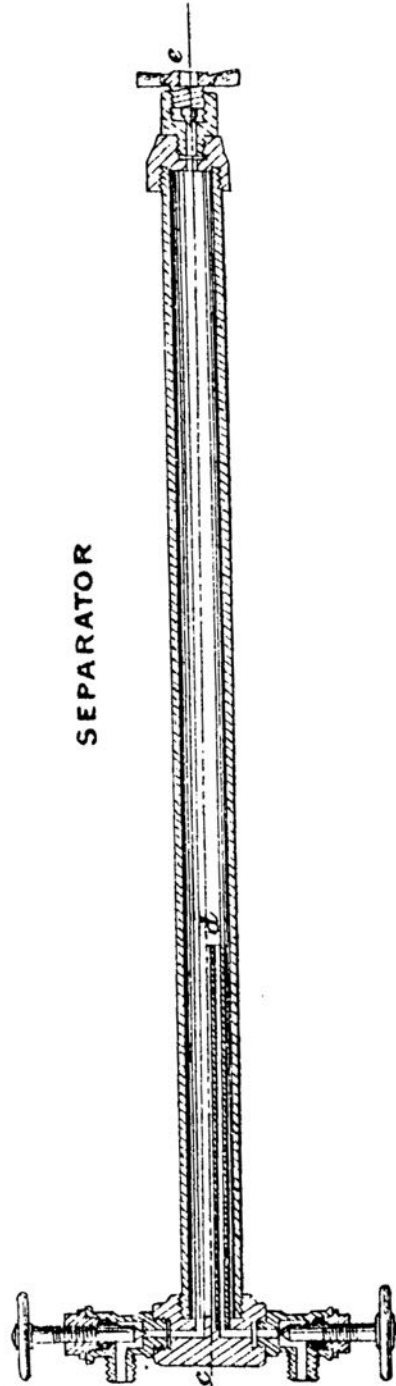


RESERVOIRS, COMPRESSED AIR.

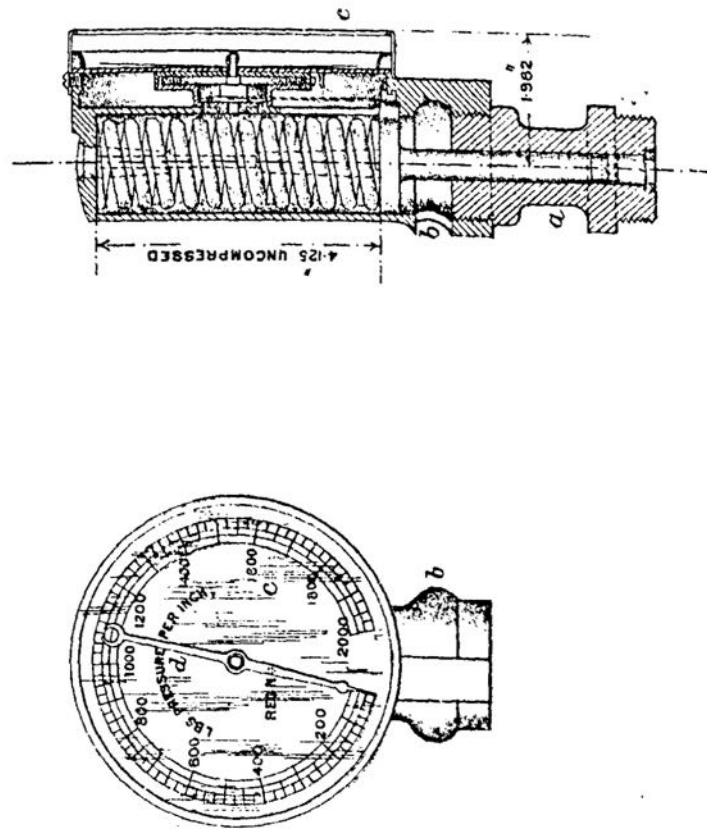
MARK II.



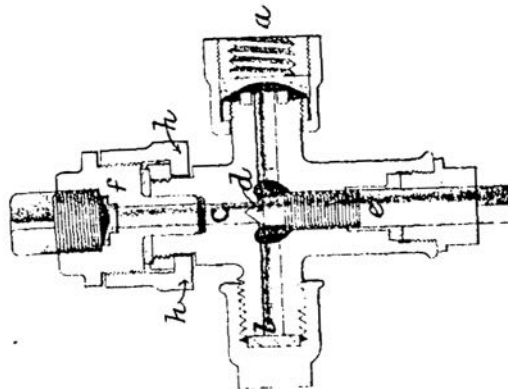
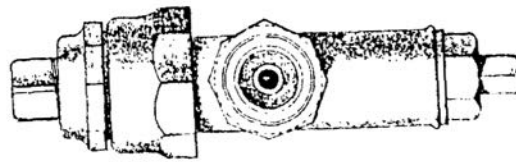
SEPARATOR



INDICATOR, PRESSURE, SPRING.

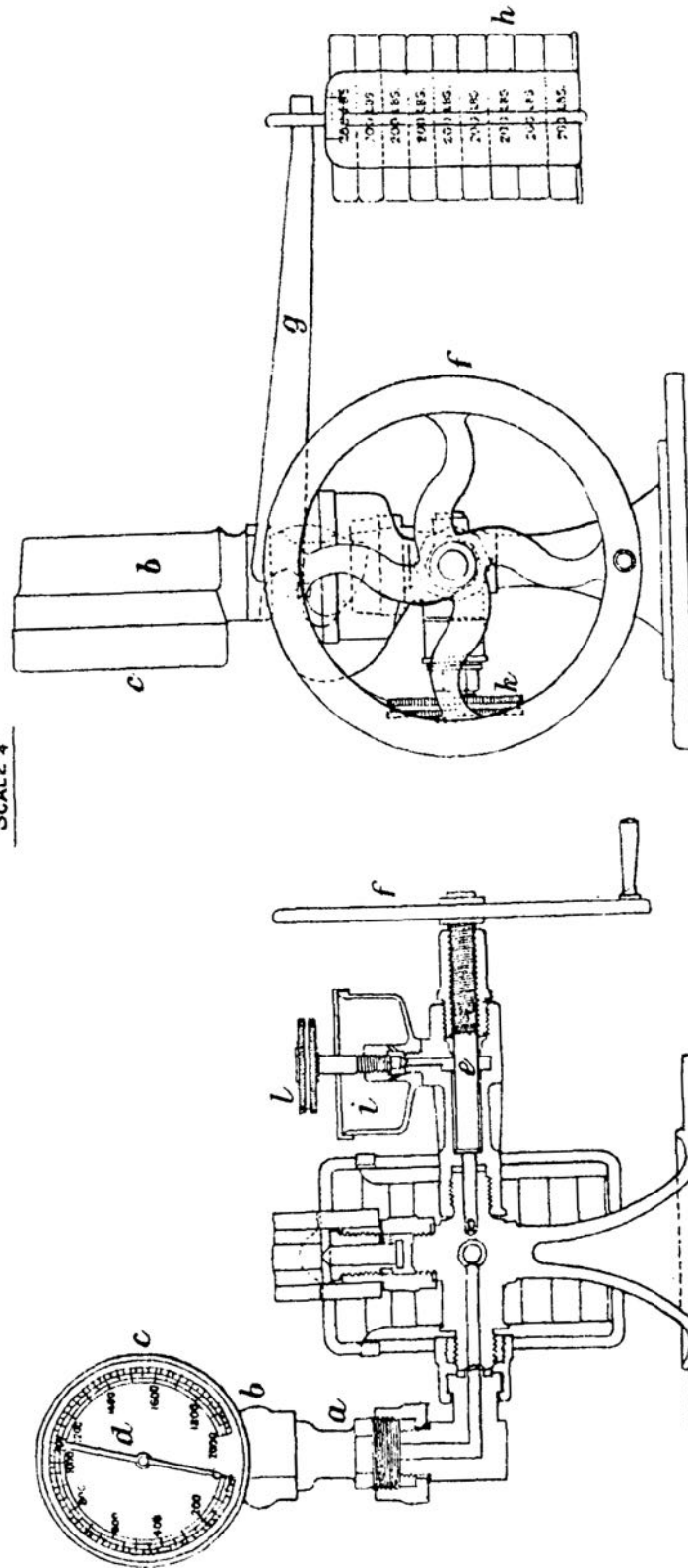


CONNECTION, INDICATOR, PRESSURE, CARRIAGE, GARRISON, HYDRO-PNEUMATIC.



Gauge, Pressure, Dead Weight, Testing.

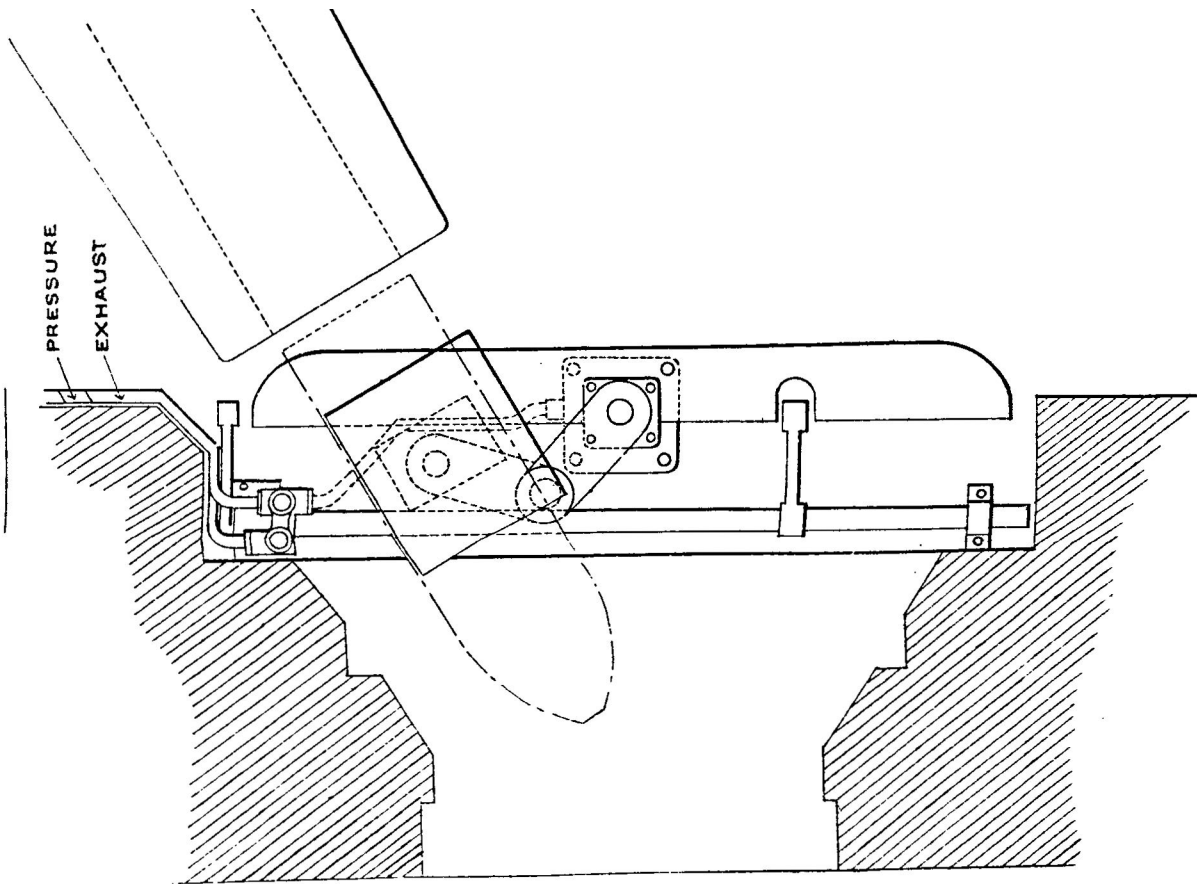
SCALE $\frac{1}{4}$



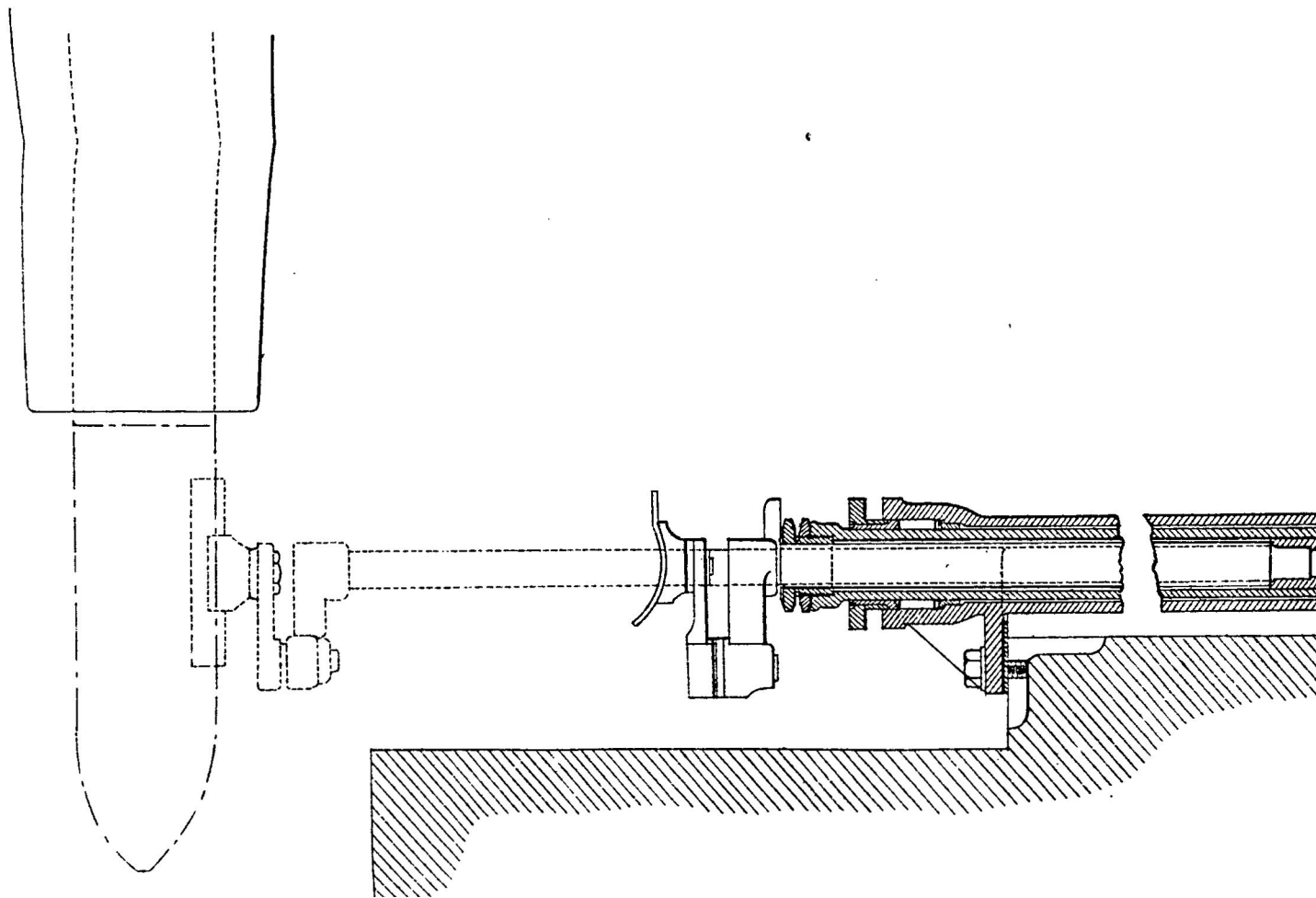
END ELEVATION.

SECTIONAL ELEVATION.

PLAN

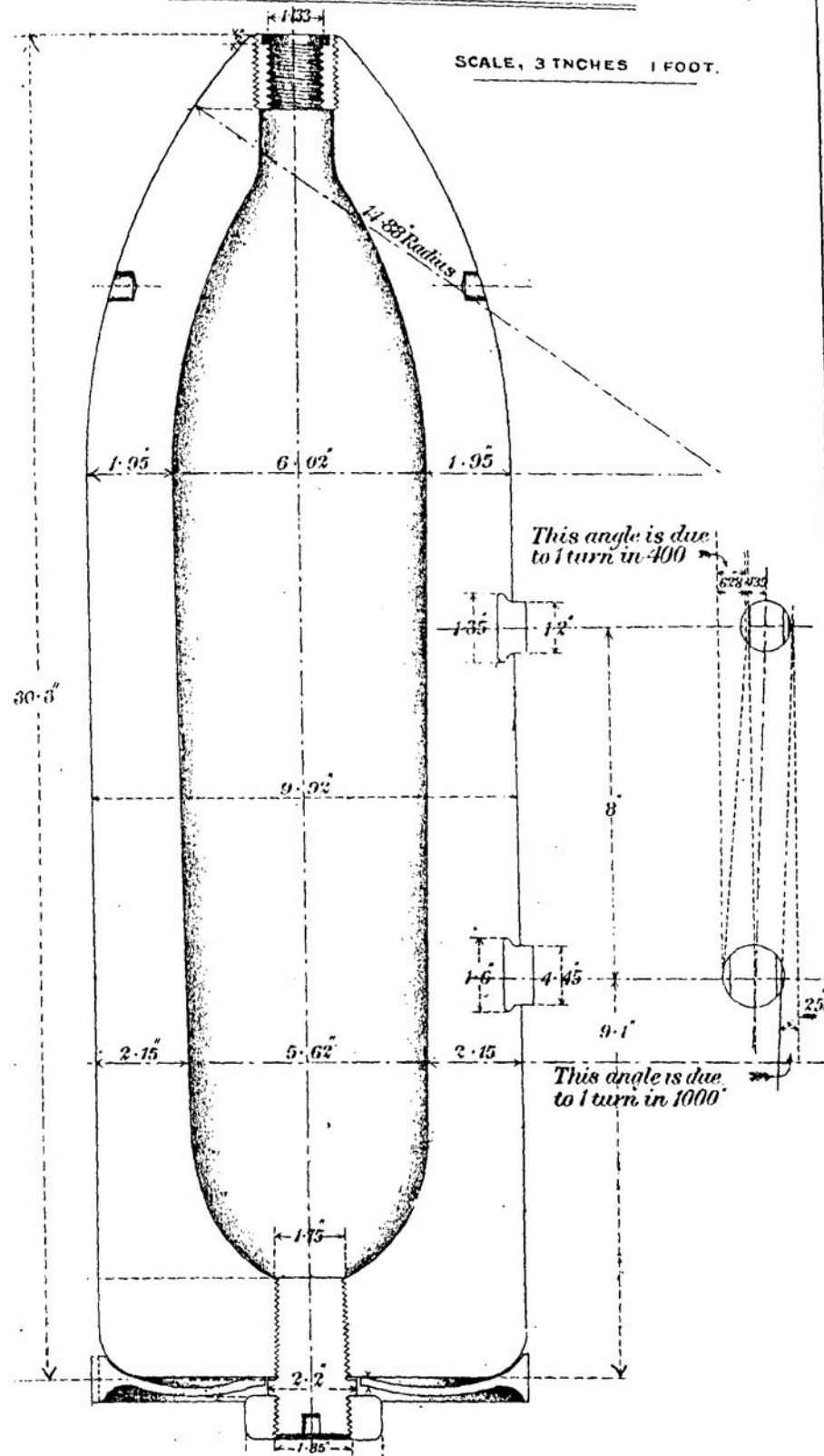


SECTION

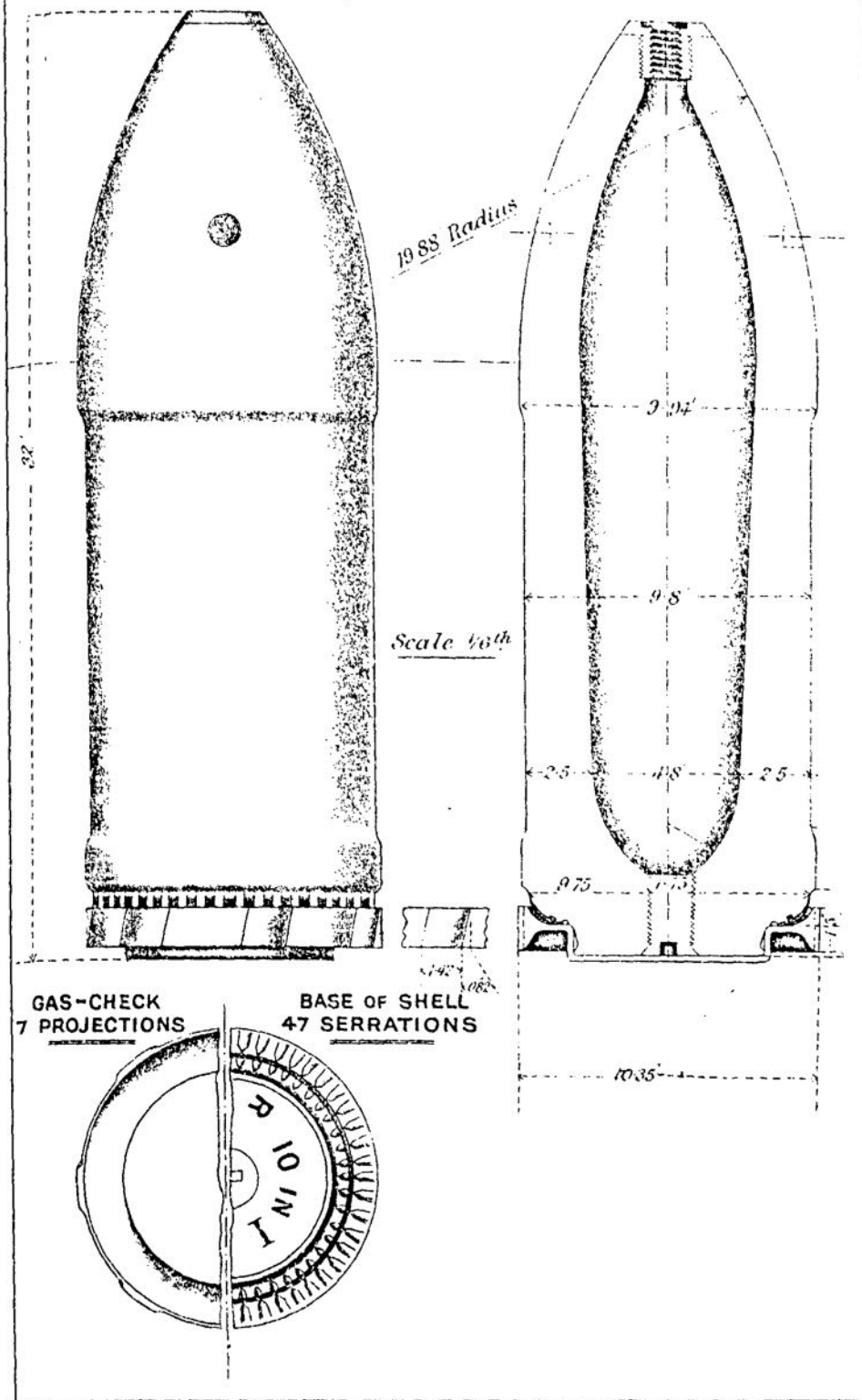


SHELL, R. M. L. COMMON, 10 INCH, STUDDED, MARK III.

SCALE, 3 INCHES = 1 FOOT.

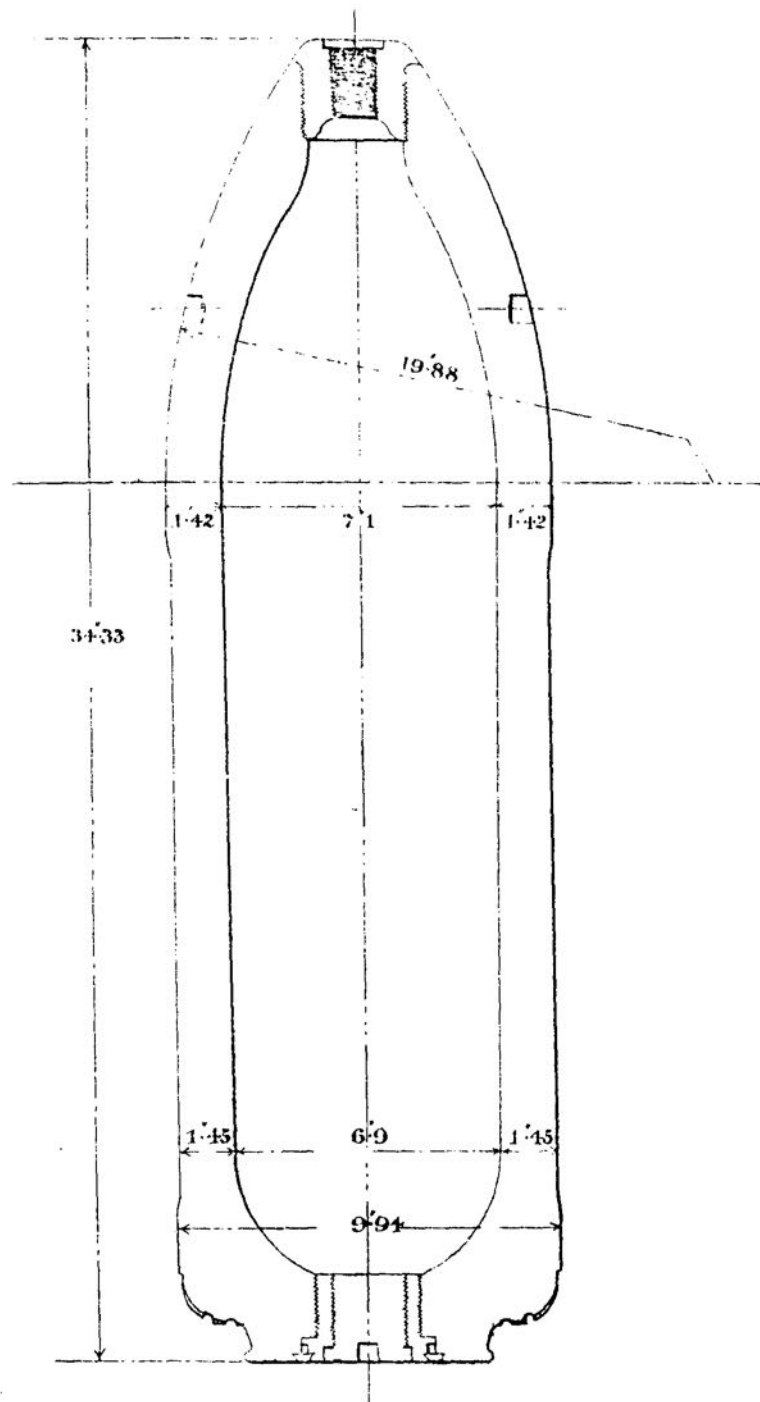


SHELL, R.M.L. COMMON, STUDLESS, 10 INCH, MARK I.



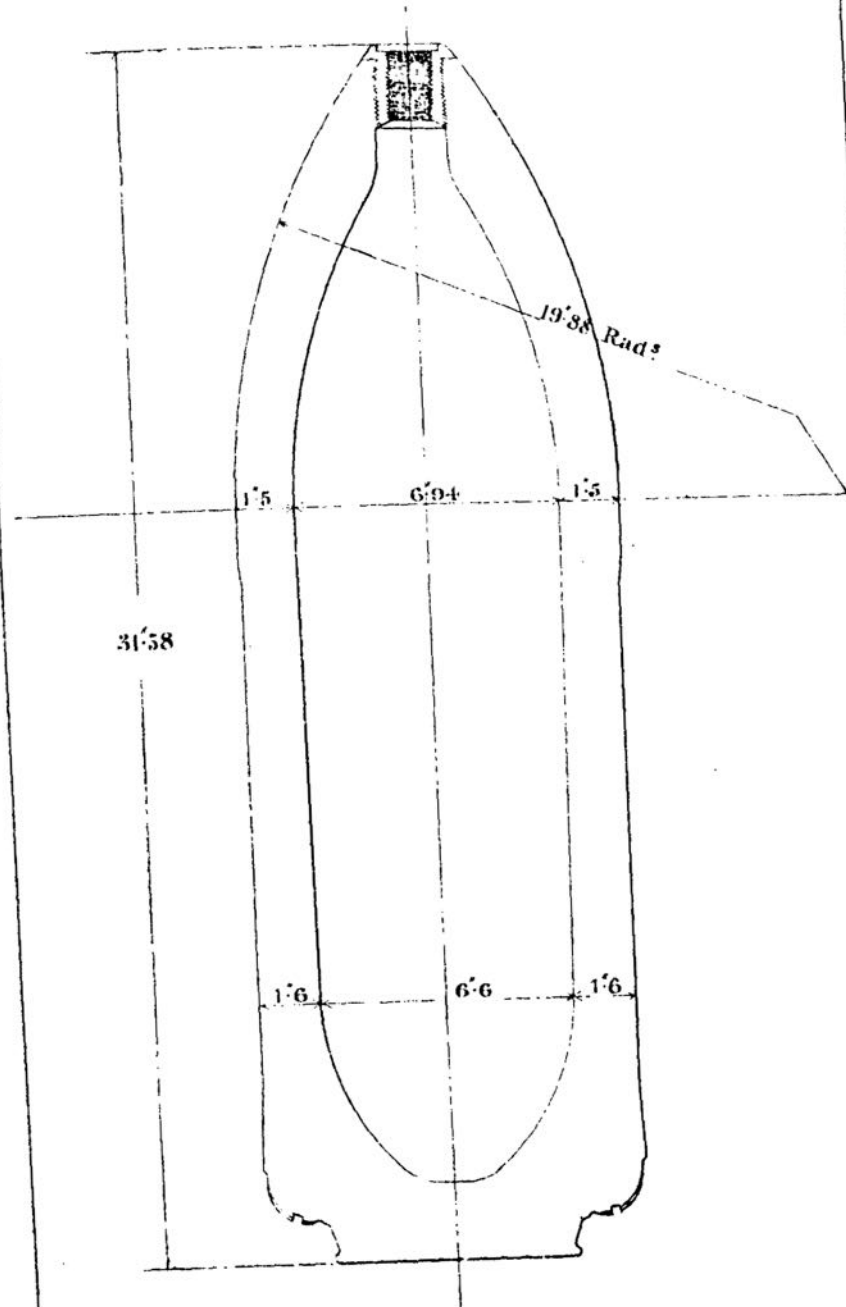
SHELL, R.M.L.COMMON, 10 INCH, STUDLESS, CAST STEEL, M^o III.

— SCALE $\frac{1}{5}$ —



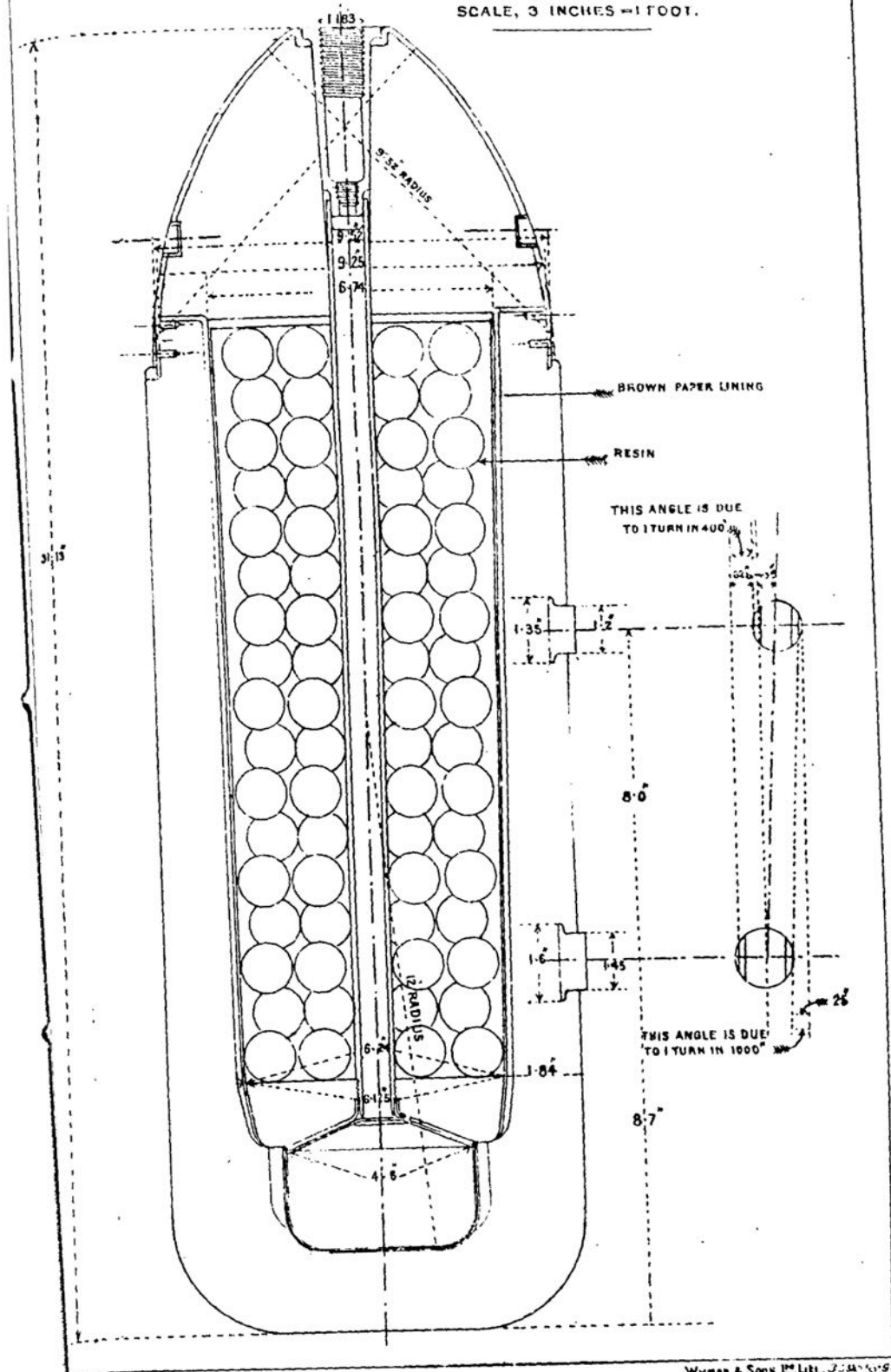
SHELL, R.M.L. COMMON, 10 INCH, STUDLESS, F.S., MARK I.

SCALE $\frac{1}{5}$.

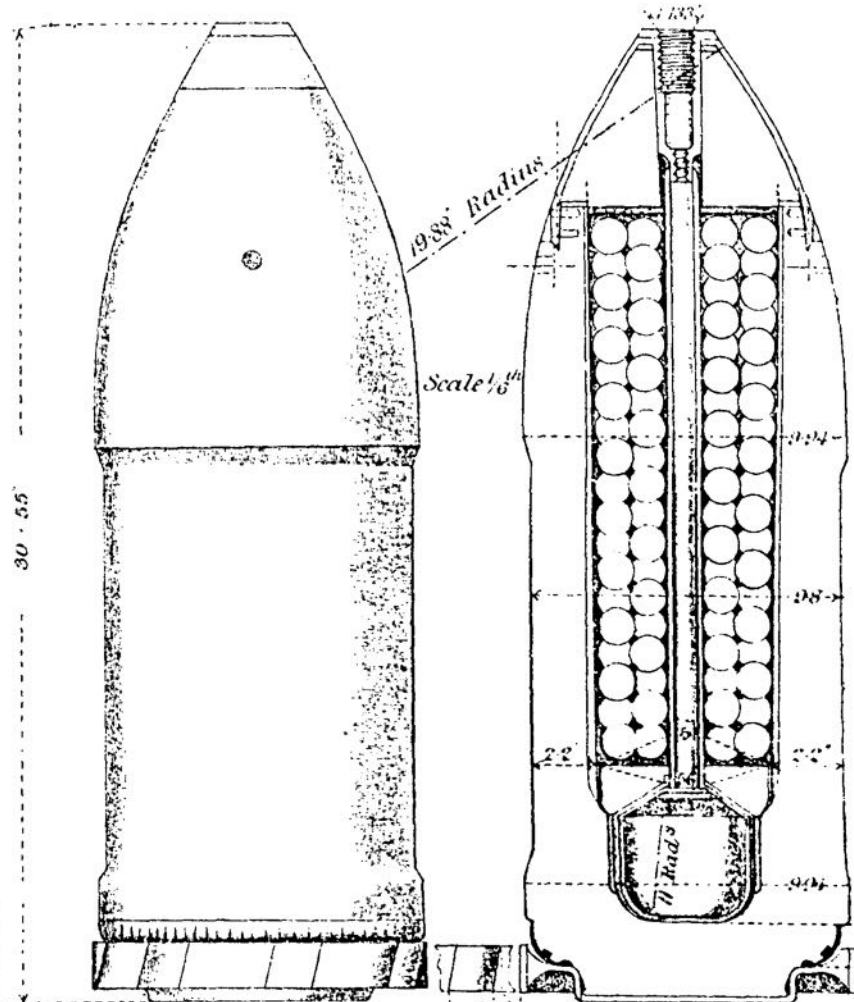


SHELL R.M.L. SHRAPNEL, 10 INCH, STUDDED, MARK III.

SCALE, 3 INCHES = 1 FOOT.

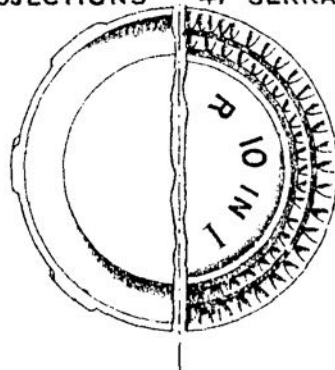


SHELL, R.M.L., SHRAPNEL, 10 INCH. STUDLESS. MARK I.



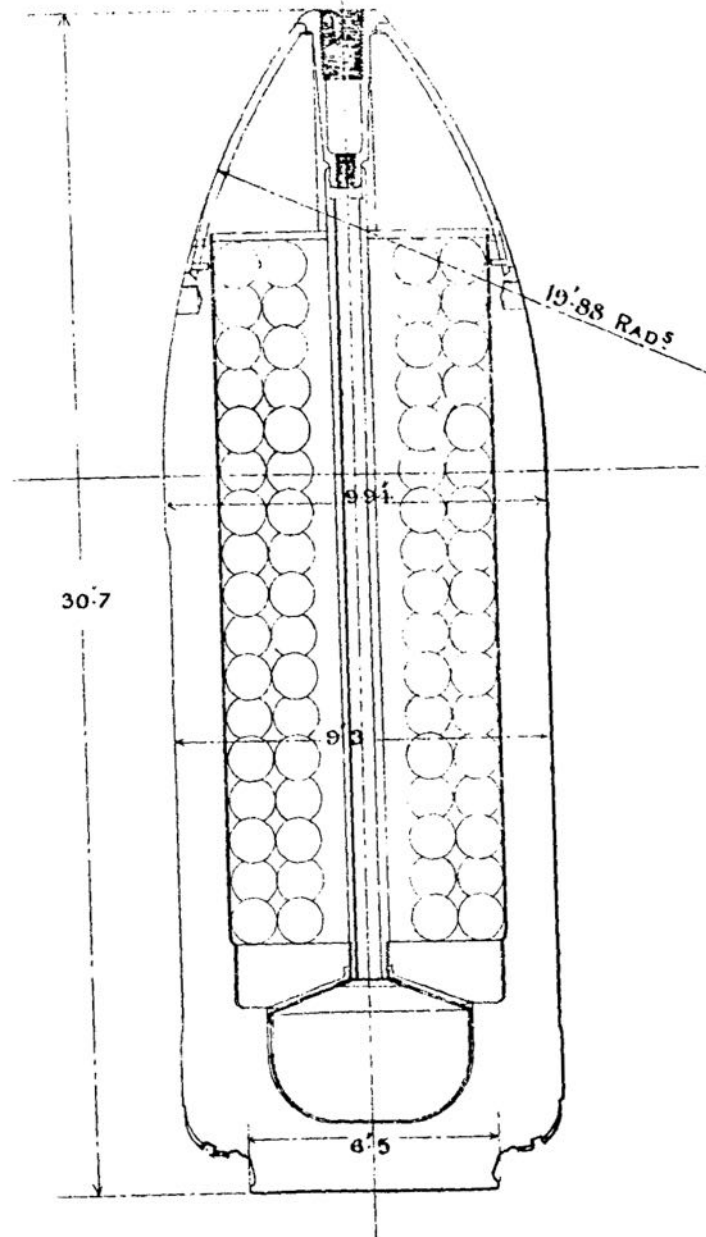
GAS-CHECK
7 PROJECTIONS

BASE OF SHELL
47 SERRATIONS.



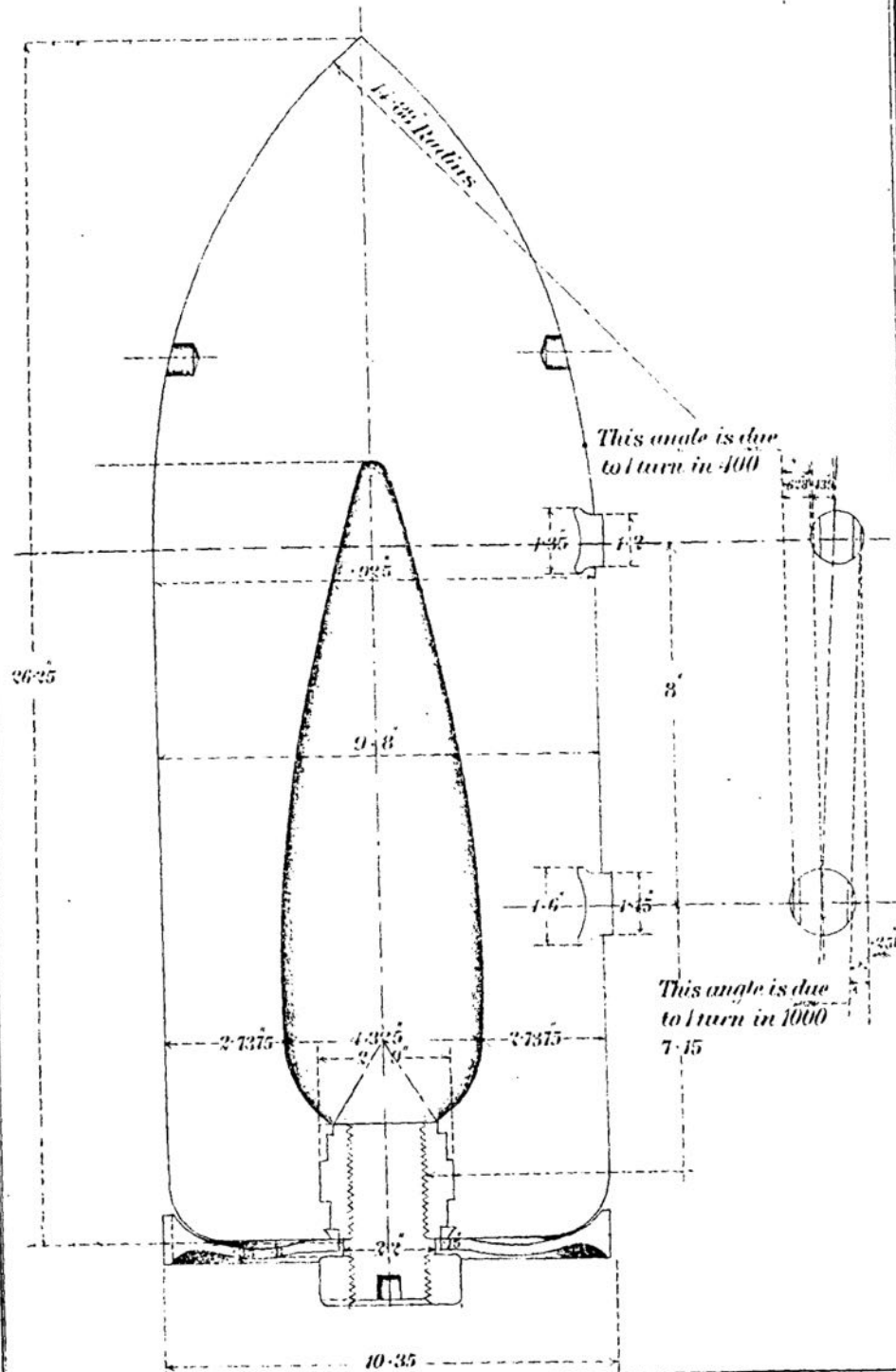
SHELL, R.M.L. SHRAPNEL, 10 INCH, STUDLESS, C.S., MARK II.

SCALE $\frac{1}{5}$.



SHOT, R.M.L., PALLISER, 10 INCH, STUDDED, MARK VI

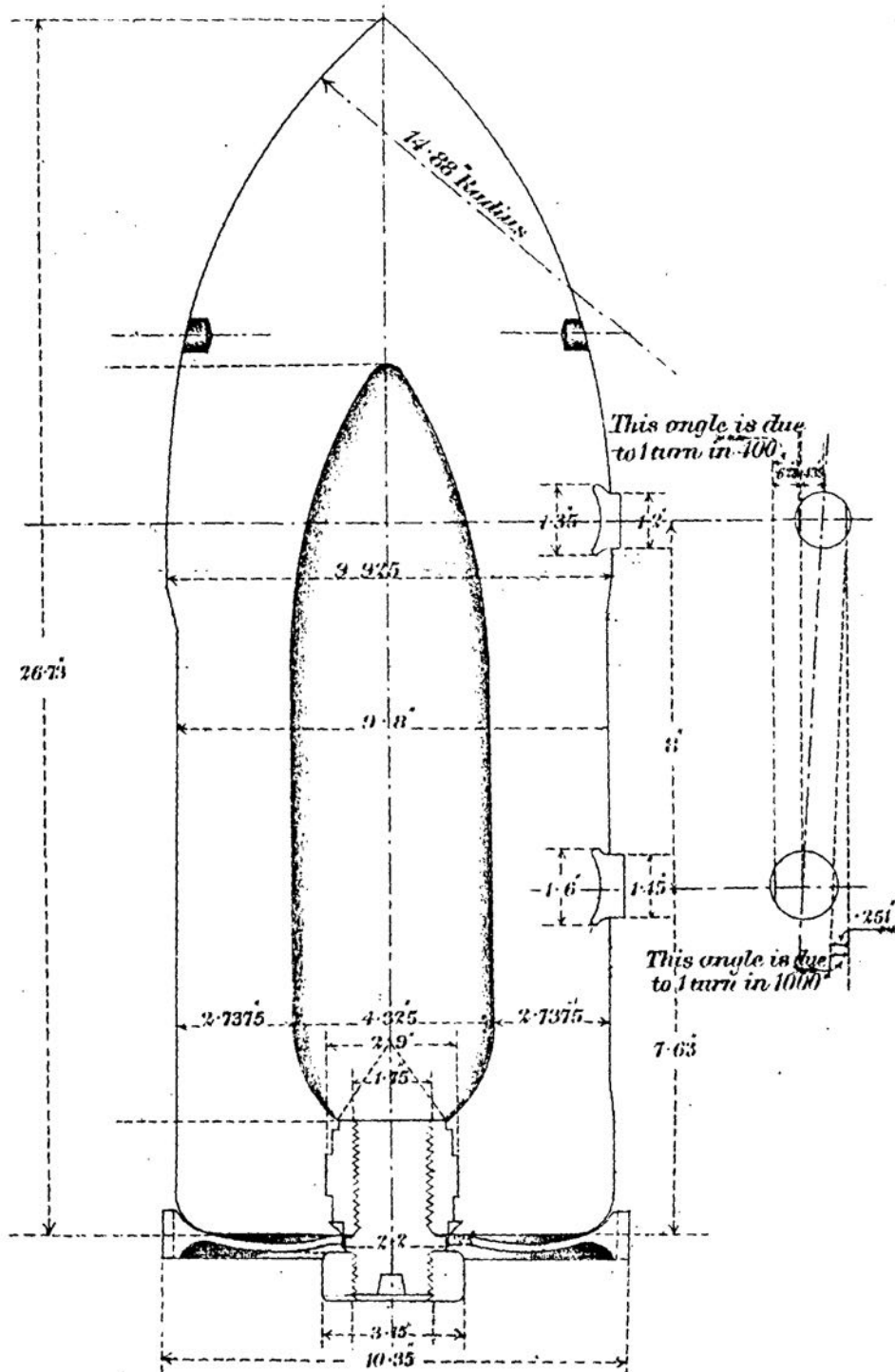
SCALE 3 INCHES = 1 FOOT.



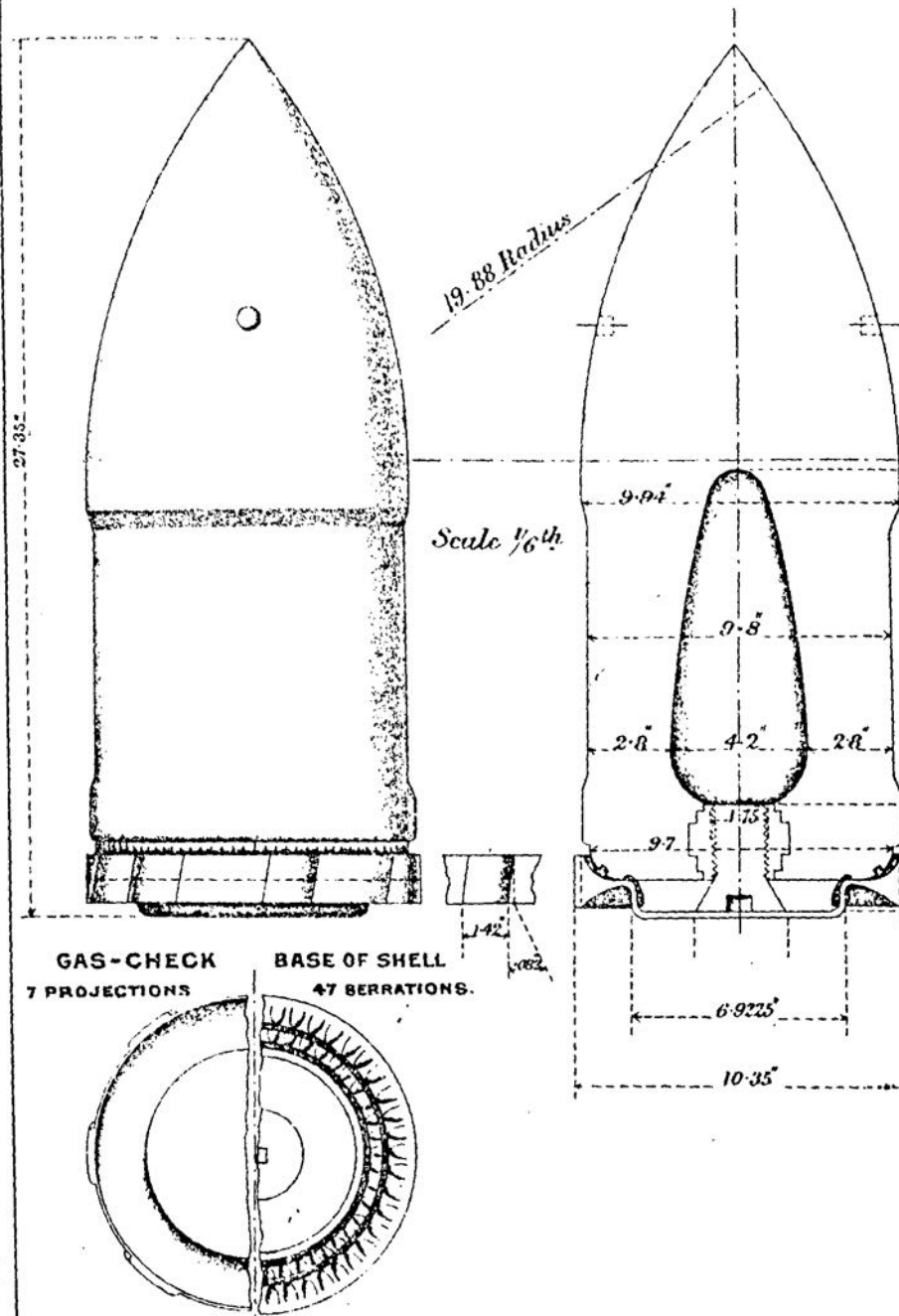
*This angle is due
to 1 turn in 1000*
7.15

SHOT. (FORMERLY SHELL) R.M.L., PALLISER, 10 INCH,
STUDDED, MARK IV.

SCALE, 3 INCHES 1 FOOT.

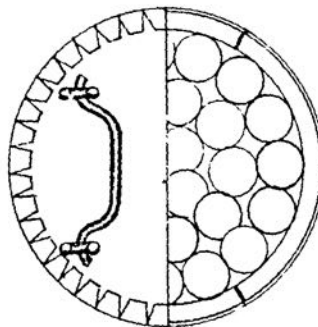
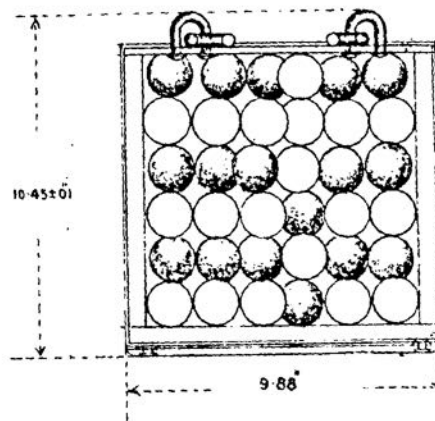


SHOT (FORMERLY SHELL) R. M. L. PALLISER,
10 INCH, STUDLESS, MARK II.



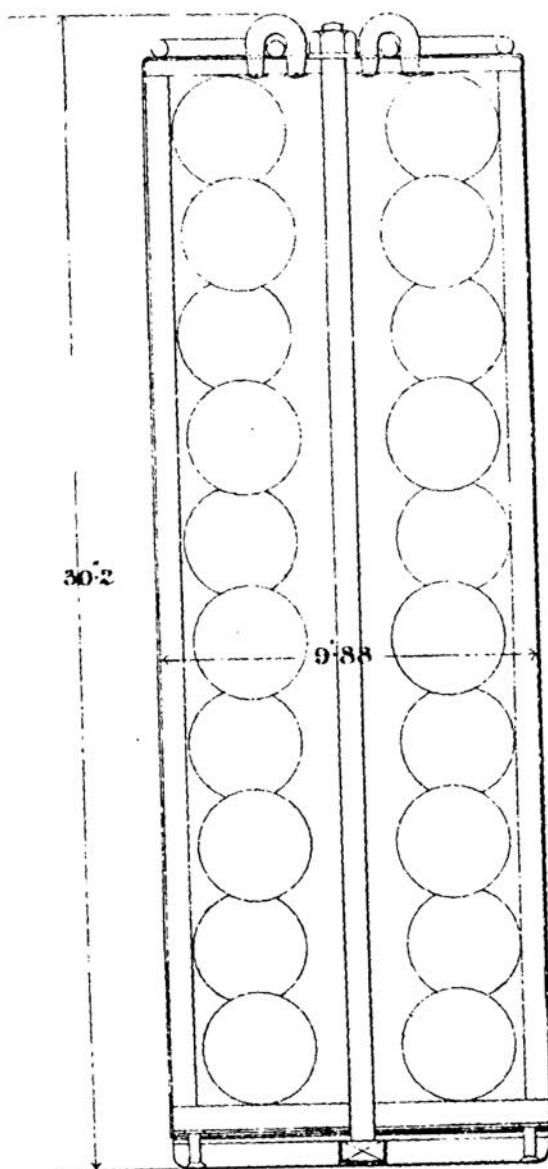
SHOT, R. M. L. CASE, 10 INCH, MARK III.

SCALE 2" = FOOT.



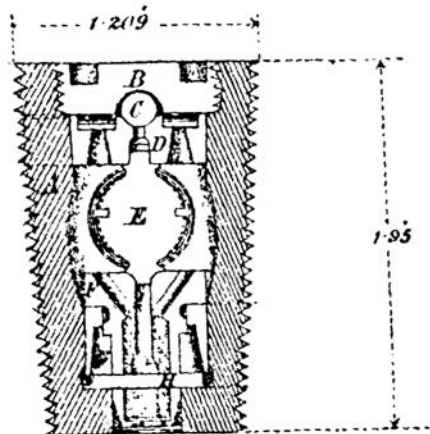
SHOT, R.M.L., CASE, SPECIAL, 10 INCH, MARK IV.

SCALE $\frac{1}{5}$.



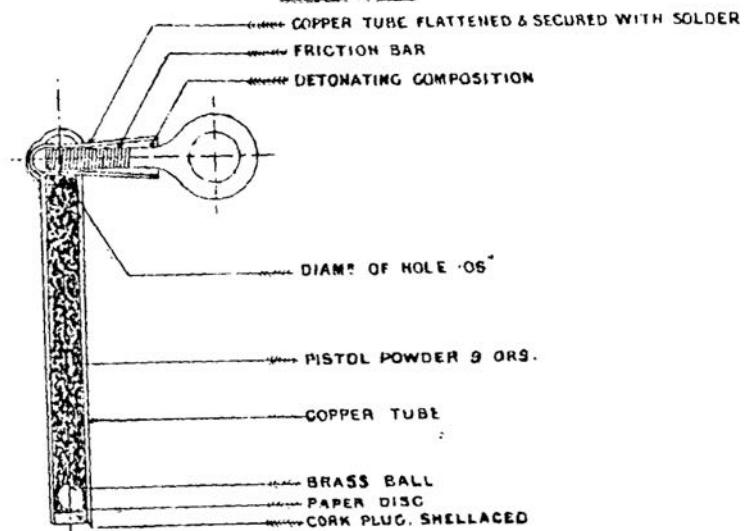
FUZE, PERCUSSION, PETTMAN, GENERAL SERVICE, N° 5, MARK II.

Full Size.



TUBE, FRICTION, COPPER, SOLID DRAWN, WITH BALL,
(MARK II.)

Full Size.



SECTION AT A.B.

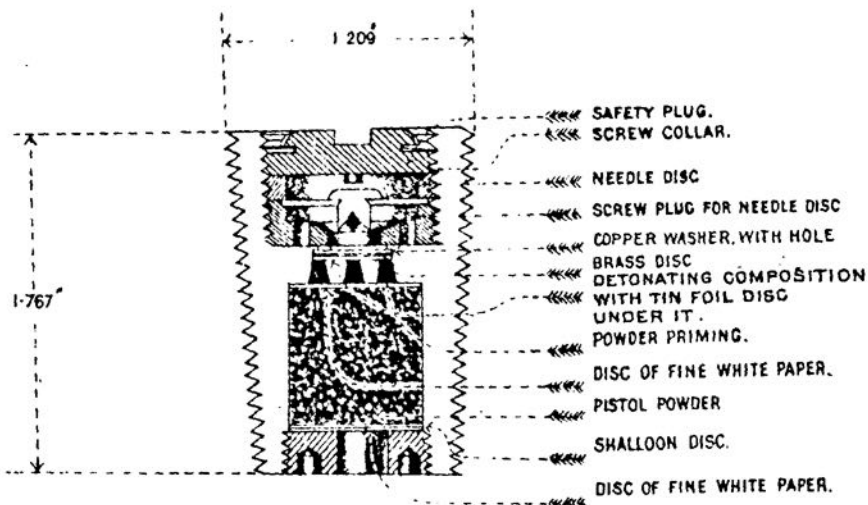


PLAN.

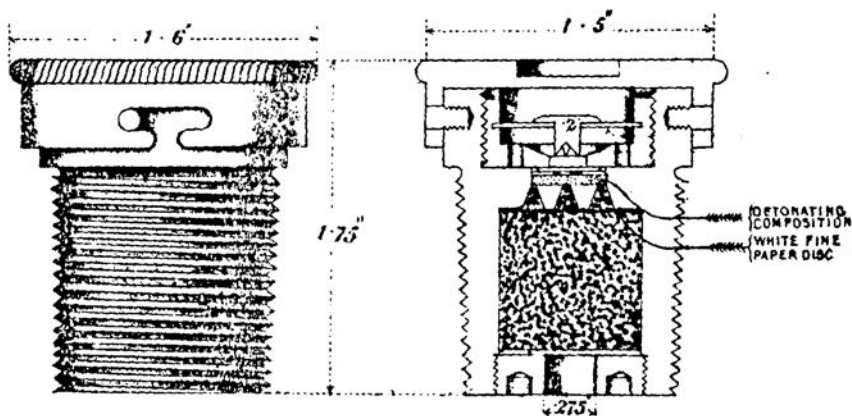
FUZE, PERCUSSION, DIRECT ACTION, N° 3,

(FULL SIZE.)

MARK III.

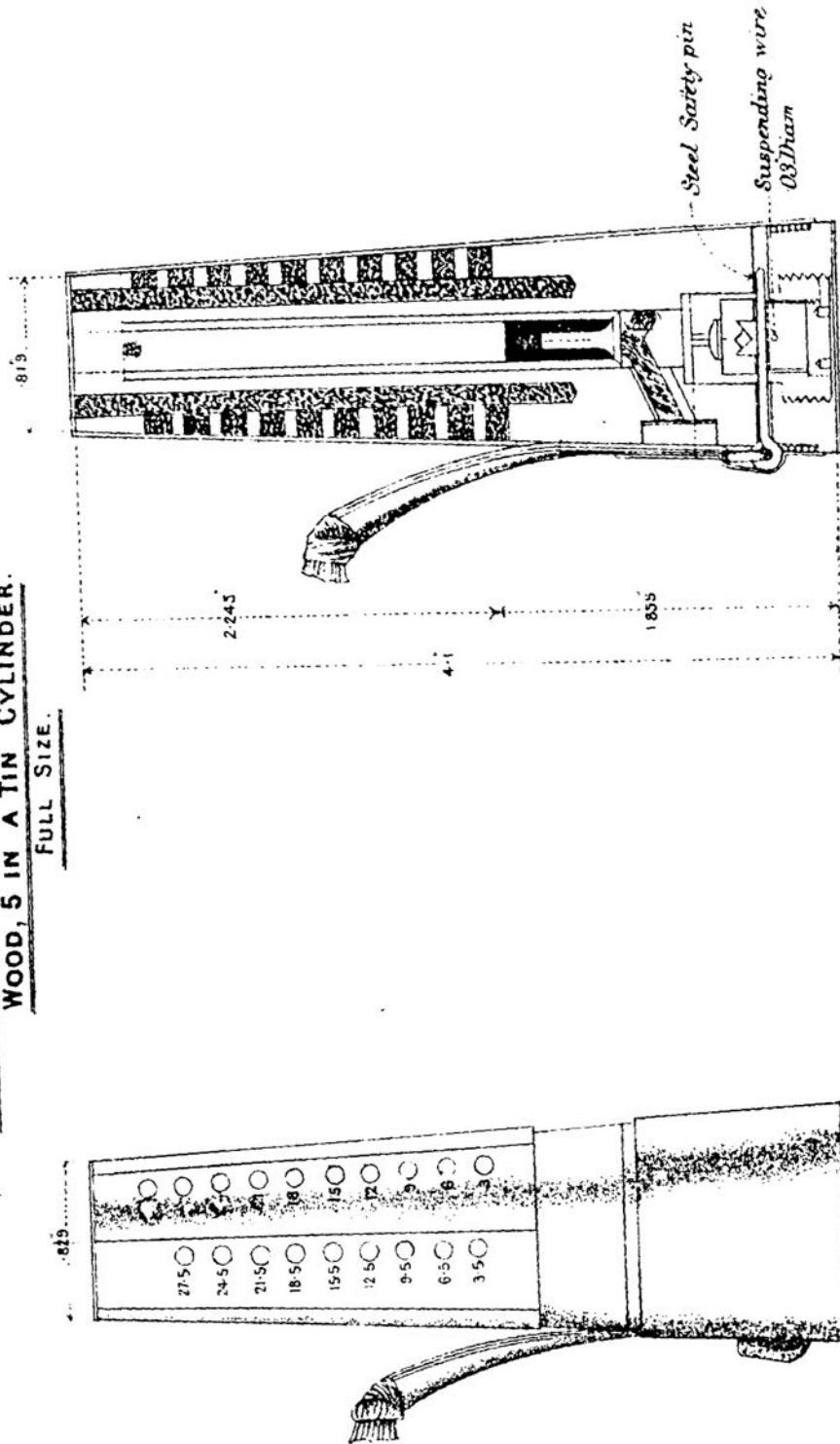


MARK II.



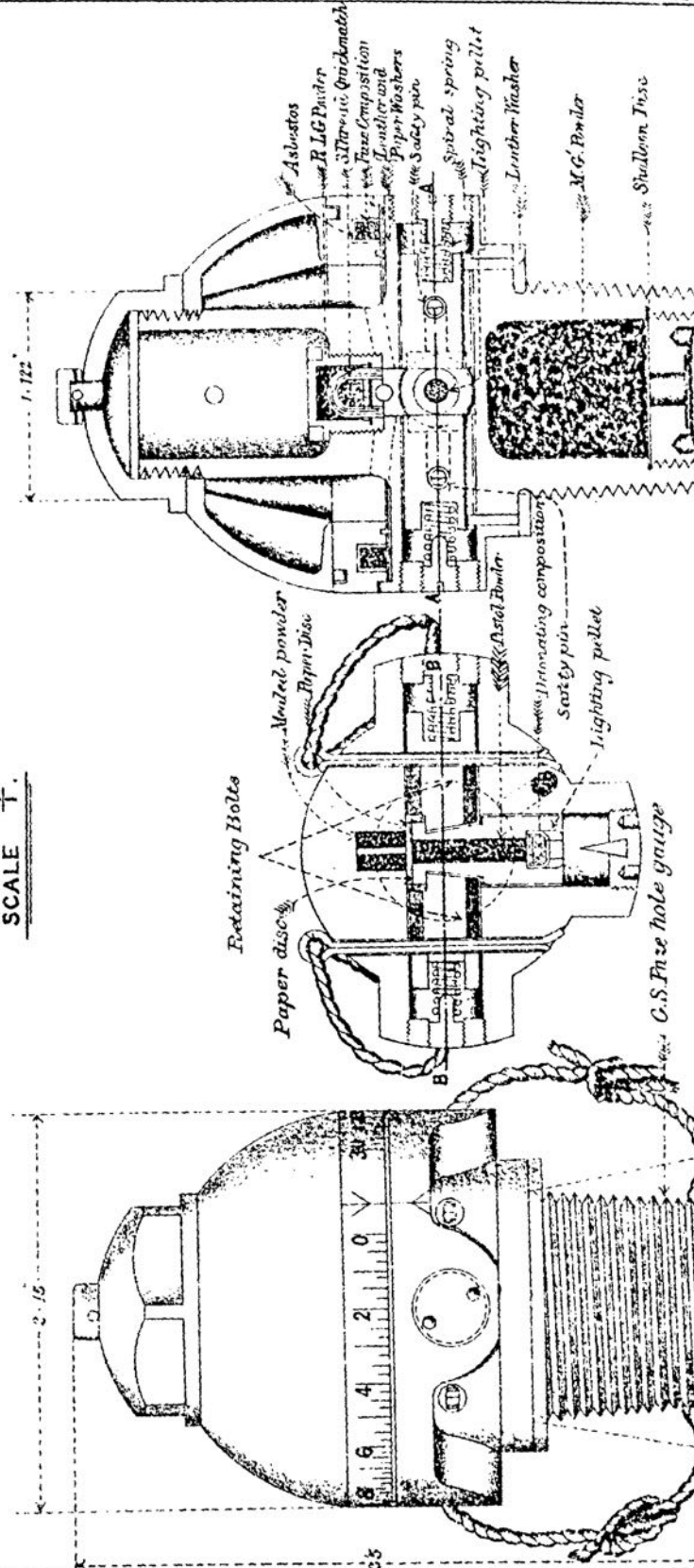
FUZE, TIME, 15 SECONDS, WITH DETONATOR, NO 43., MARK III.
WOOD, 5 IN A TIN CYLINDER.

FULL SIZE.



FUZE, TIME, SENSITIVE, MIDDLE, N° 24., MARK I.

SCALE +.



SECTION AT A. A.

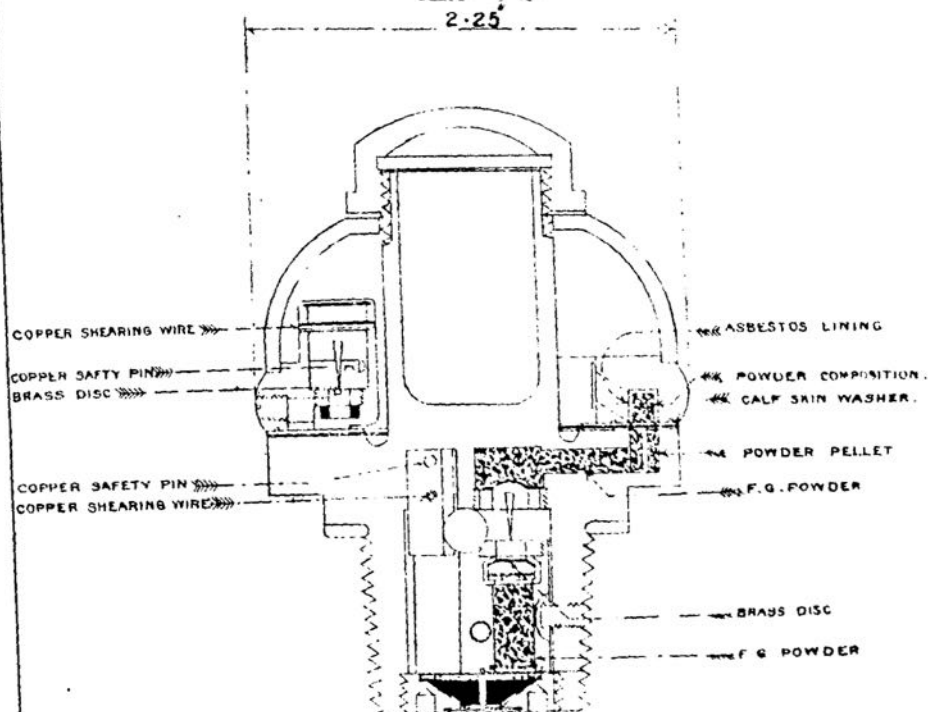
SECTION AT B. B.

ELEVATION, SET AT "SAFETY."

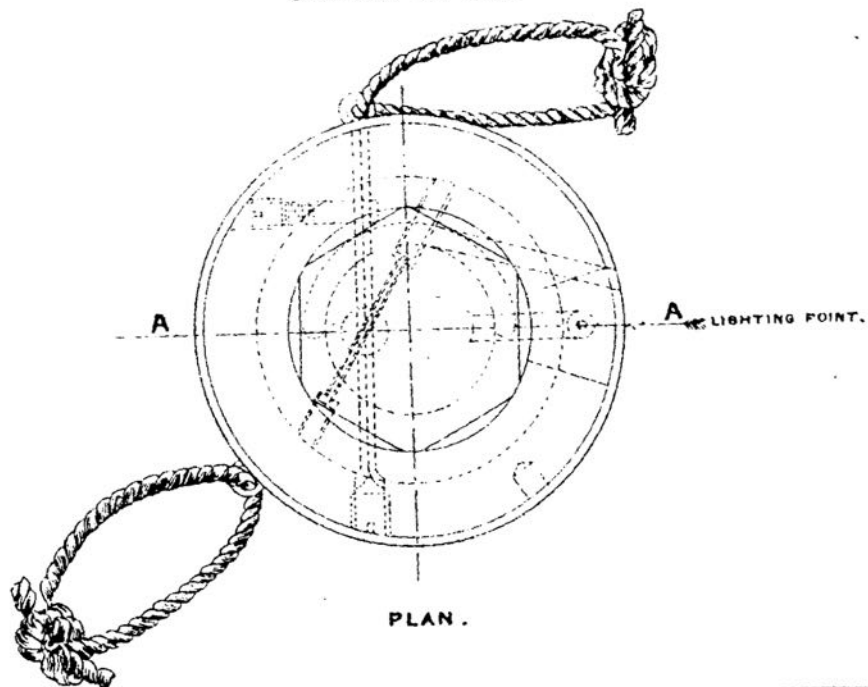
FUZE, TIME AND PERCUSSION, MIDDLE, N° 54, MARK II

METAL; 1 IN A TIN CYLINDER.

Full Size.



SECTION AT A.A.



TUBE, VENT SEALING, ELECTRIC, P. MARK V.

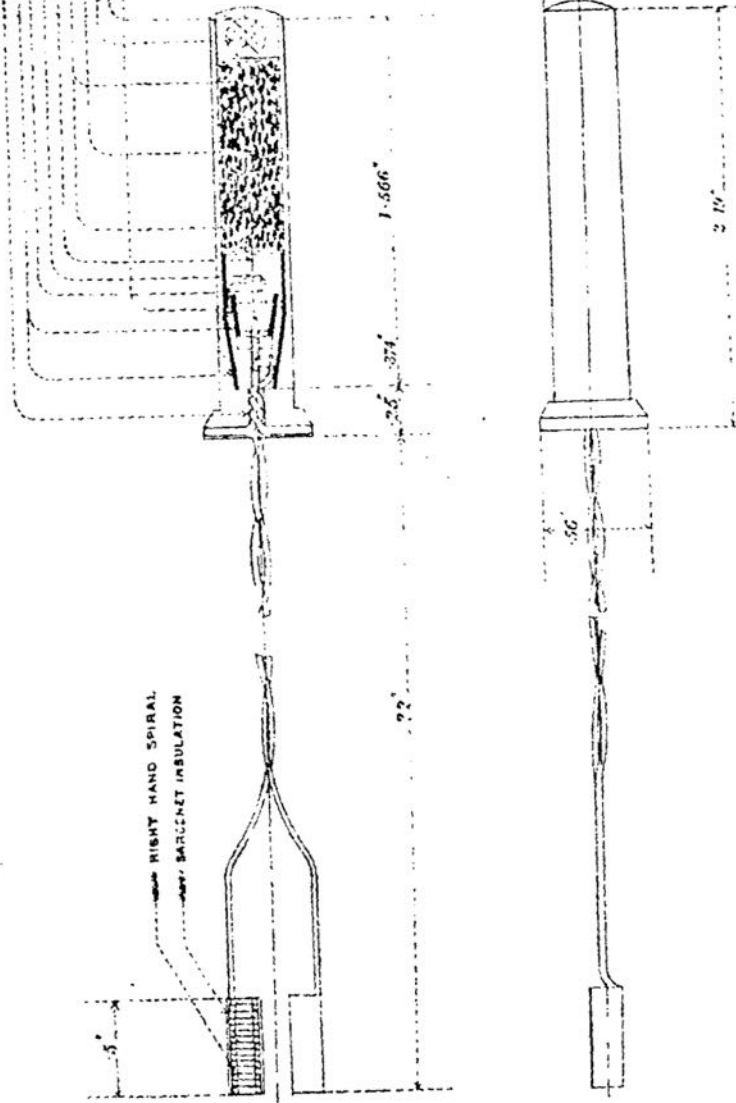
FULL SIZE.

COVER WIRE .023 DIA. COATED WITH PURE TIN. INSULATED WITH SILK EBNITE.
 COPPER POLES .02 DIA. COATED WITH PURE TIN
 PLATINUM WIRE
 COMPOSITION PAKING
 THIN PAPER DISCS
 POWDER
 1/2" DIA. BALL 1/8" DIA. TWO HOLES .045 DIA. AT RIGHT ANGLES
 SULPHUR
 SHEET EBNITE.

RIGHT HAND SPIRAL
 BARGENET INSULATION



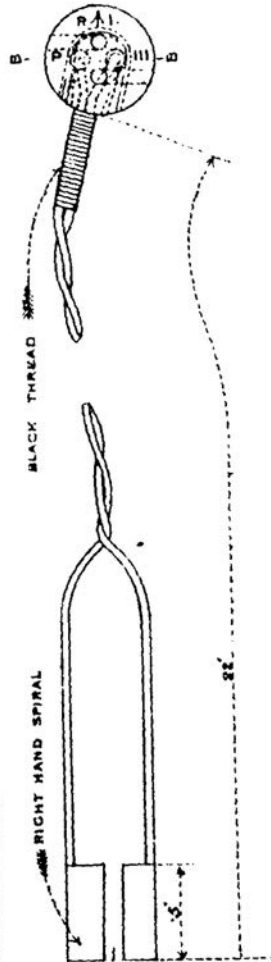
END VIEW.



TUBE, VENT-SEALING, ELECTRIC, P, DRILL, MARK III.

GUNMETAL, FOR GUNS WITH PERCUSSION LOCKS.

FULL SIZE.



END ELEVATION.

FULL SIZE.

COPPER WIRE .035 DIAM: COATED ALL OVER WITH PURE TIN
INSULATED WITH SILK AND TWISTED
GUNMETAL

ESONITE CYLINDER

COMPOSITION PRIMING

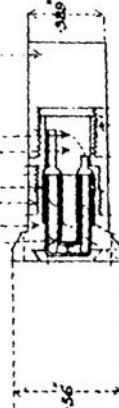
PLATINUM SILVER WIRE

B



TWO ESCAPE HOLES .025 DIAMETER
STOPPED WITH LUTING ON THE OUTS DE.

B



SECTION AT A. A

SECTION AT B. B.